CAMBRIDGE SYSTEMATICS

Feasibility Assessment

Functional Requirements Analysis and Implementation Strategy for the Transportation Enterprise Asset Management System (TEAMS)

technical memorandum

prepared for

District of Columbia Department of Transportation

prepared by

Cambridge Systematics, Inc.

with

Dewberry
DataNet Systems

October 2003

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Executive Summary

This section summarizes the main findings of the Task 1 Feasibility Assessment Technical Memorandum. The purpose of this first task in the TEAMS Phase I effort is to document DDOT's existing and proposed information systems related to TEAMS, and assess the extent to which these systems adequately support current and future business requirements. The enterprise systems analysis is performed from a "top-down" perspective combined with a business review of asset management practices in each of the main business areas.

Asset Management and Enterprise GIS Subsystems

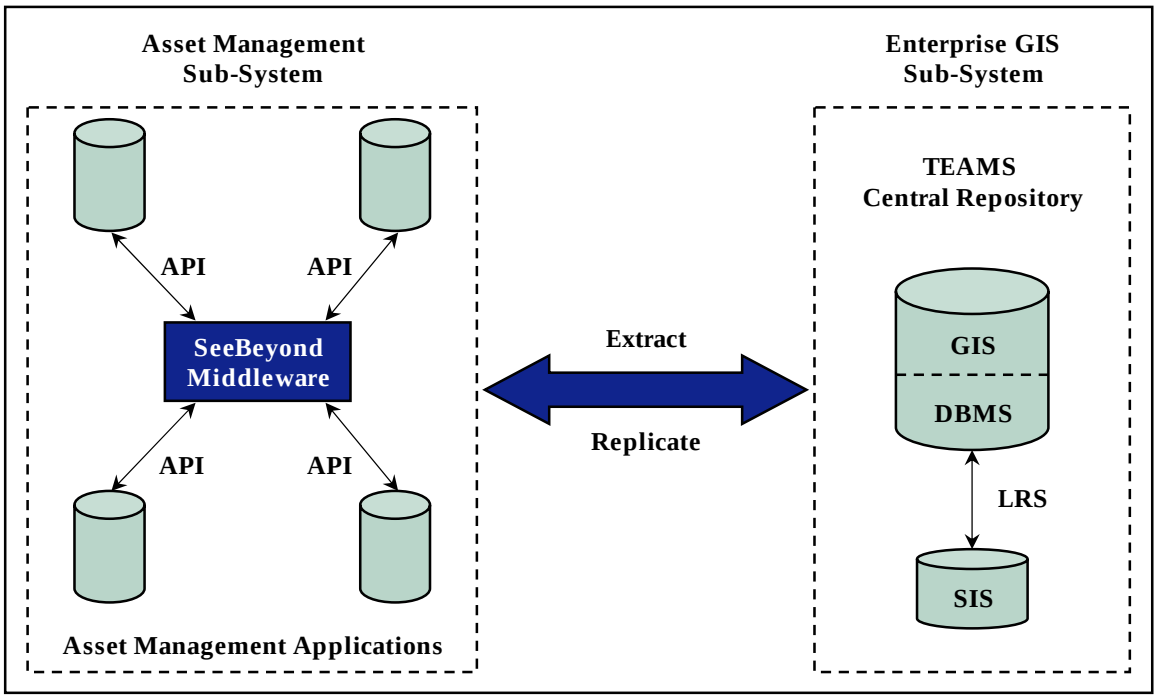
The TEAMS concept defines two main subsystems; the Asset Management Applications subsystem and the Enterprise GIS subsystem (see Figure 1). TEAMS is an ambitious project with a number of complex features. In order to manage the complexity, it is recommended the TEAMS concept of operations be described as two subsystems that will foster data integration internally and externally. In this way, the design and development can be divided into manageable pieces, always keeping in mind the ultimate vision of a fully integrated system.

The feasibility (and ultimate success from a technical standpoint) of TEAMS will be affected by the level of data integration to support business processes *within* each subsystems and *between* the two subsystems.

In the Asset Management subsystem, the middleware software will play the role of data broker between the databases and applications, while in the Enterprise GIS subsystem, location is the common denominator. Currently the two subsystems are somewhat independent with ad hoc interfacing between the applications and the GIS. The TEAMS goal is to break down these barriers and create synergy between the two subsystems. For example, when the TEAMS vision is realized, asset management applications should contain the SIS ID, which will enable mapping of their data in the GIS. Similarly, the TEAMS geodatabase will contain foreign keys to the asset management databases, enabling synchronization between the spatial features and asset management data.

DDOT would like to create an architecture whereby applications that conform to the TEAMS standards can "plug and play" with the TEAMS system. Most of the existing systems have some limitations in their compatibility with the TEAMS system architecture, and part of the design task in the next phase will be to determine the extent to which applications need to be customized to meet TEAMS requirements. The expectation is that middleware like e*Integrator and web-based services will minimize the amount of customization required.

Figure 1. TEAMS Subsystems



To summarize, TEAMS will achieve integration of asset information to the extent that its component systems conform to a standard architecture comprising:

1. **Open API (Application Program Interface)**. DDOT is testing a middleware software program from SeeBeyond Inc., called e*Integrator, which acts as a bridge between different databases and data formats. E*Integrator has the potential to enable data sharing between users so long as the applications have an API that will allow the data to be exported and imported. The e*Integrator program is being tested between the Hansen Call Center application and the Cityworks-Azteca Trees application (the data from Hansen will be exported to an Oracle database for use by the Trees application)

2. **Linear Referencing** – To take advantage of the GIS mapping and querying capabilities, all applications must include fields for location referencing, such as the SIS ID. Other location referencing methods can be used such as street addresses or latitude/longitude, and the GIS will provide translation tools to enable data conversion between the different location referencing methods.

3. **Configuration Management**. It is envisioned that the TEAMS Central Repository will include a geodatabase that serves a spatial data warehouse function. A geodatabase integrates the spatial and attribute data in a single data model and manages the relationships between the features. This repository must either contain a replica of the asset data from Asset Management Applications, or it must include the capability to provide real-time links to their data. In the latter case, the repository must contain the

appropriate asset entity, with any necessary identification information to link to the locally stored data. In order to ensure that information stays synchronized between the repository (which is the authoritative source for spatial information) and the asset management applications (which are the authoritative source for non-geographic attribute data), the applications must be hooked into the geodatabase model at some level and enable data transfer via ODBC protocols.

4. **GIS Compatibility**. DDOT has standardized on the ESRI GIS platform for its server, client and web products. Applications that keep their data local and require a thick client interface must be compatible with ESRI data formats such as ESRI shapefiles if their data is to be mapped. Some applications provide interfaces to GIS programs, like ArcView and ArcIMS. Even so, if their data is to be shared with other users through the GIS, there should be a corresponding entity in the geodatabase that allows the data to be interfaced with the TEAMS data warehouse. In the TEAMS vision, data loaded into the data warehouse will be spatially enabled in the geodatabase, rather than in local databases, and made accessible via Web-GIS or desktop GIS clients. These users do not have to worry about how to map their data.

■ Business Case for TEAMS

Over 30 stakeholders were interviewed, and information was gathered on more than 23 existing and planned information systems related to TEAMS functionality. As a rule, stakeholders were very supportive of the objectives of the TEAMS project. Mechanisms to integrate information, make it easily accessible via a web interface, provide map-based interfaces and easy to use mapping capabilities would be viewed as extremely beneficial and useful. Numerous examples were cited of how more centralized, integrated set of asset information would help asset management processes to be more cost-effective, efficient, and yield greater benefits to the customer. Specific business objectives that would be supported by TEAMS include:

- Improving coordination of work across different business units responsible for the same assets;
- Improving access to timely and accurate information about asset condition, characteristics, capital projects, and maintenance work activity status;
- Providing a sound, credible basis for priority setting and resource allocation decisions with respect to maintenance, rehabilitation and improvement of assets;
- Facilitating performance measurement, and management reporting functions; and
- Facilitating the efficient and accurate preparation of external reports that draw upon disparate data sources.

A number of limitations with existing systems were mentioned by stakeholders which broadly fall into the following categories:

- Most applications have limited or no ability to exchange data with other applications or databases.

- This impacts business processes that require information about the activities of other business units, for example UFA tree removal/pruning need to know if permits have been issued for surface construction work in the planned work area.

- Most applications have no mapping tools or the ability to locate assets on the base map. Even where GIS is used it is limited to querying or mapping of specific features. There are no map interfaces for data input or for tracking work flow.

- Many applications do not use any form of location referencing such as the SIS ID so even if GIS was available they would have difficulty using it without geocoding their projects and work activities.

- Permit tracking and maintenance management/work order/activity tracking systems are not standardized or integrated.

- Capital project tracking and interfaces to financial systems such as SOARS are not automated.

Even if an application is considered a good system in a specific business area, there are broader business requirements that support the development of a more integrated approach. In fact, several systems are currently planned to be replaced or upgraded, pending the results of this project. A few other systems are in test mode at this time, such as the Cityworks-Azteca Trees application, which may serve as a model for how some of the data integration is accomplished. The Trees application takes data from the Hansen Call center and combines it with the UFA database of tree locations, etc., in a GIS mapping system.

The disparate databases and variety of applications in use in DDOT provide a strong business case for the TEAMS concept. Clearly, there are user requirements for data sharing and easier querying via map interfaces. Current business processes are hindered by the lack of these capabilities, which impacts productivity and the ability of the Divisions to meet their performance goals.

The District has embarked on an aggressive program to improve service to district residents including coordinating work programs, improving response times to complaints and monitoring activities more closely. These objectives require efficient and robust information systems to support the data collection, data management and data analysis. The TEAMS vision is entirely consistent with this approach. Other state and local agencies have developed similar systems for integrating their asset management data, and the technologies specified in the TEAMS architecture are, for the most part, proven products.

As described in Section 5.0, there are a number of commercial systems on the market that are potential candidates to serve as part of the TEAMS suite of applications. Several of them already provide API's and interfaces to GIS. The timing of TEAMS appears to be good in terms of being able to take advantage of these technologies, especially as several business areas are looking to replace or upgrade their applications.

1.0 Introduction

1.1 Background

According to a recent review of asset management practices in transportation,… "data integration is a fundamental requirement for Transportation Asset Management, a strategic approach to maximizing the benefits from resources used to maintain, operate and expand the transportation infrastructure. The goal of data integration is to consolidate or link the data that exist in separate files or database systems so they can be used to make decisions within and across asset types. State and local agencies know that without an integrated set of data they can never make strategic and comprehensive transportation investment decisions."[1] The District of Columbia Department of Transportation (DDOT) has long recognized that data integration is the key to improving asset management and has embarked on an important initiative to address the issue. Following internal discussions with the operating divisions, the Office of Operational Support and Applied Technology (OSAT) has outlined a vision for a Transportation Enterprise Asset Management System (TEAMS). The vision for TEAMS is an enterprise solution that can integrate information using location or spatial referencing as the common denominator. TEAMS is an ambitious project to integrate data between the many asset databases and applications in use in DDOT.

The TEAMS project will meet a number of objectives, including:

- Improve or enhance business processes for asset management and decision-making;
- Migrate existing stove-pipe spatial and attribute data systems into an enterprise-wide integrated manageable system;
- Facilitate data sharing within and across DDOT's business administrations; and
- Promote technology upgrades within DDOT by using cutting-age information technology, relational database management systems, and web technology.

TEAMS will be built on the core technology of Geographic Information Systems (GIS) and will use location referencing as a core model in the enterprise environment. When complete, it will provide an enterprise solution that serves the business needs of the five

[1] Review of Data Integration Practices and their Applications to Transportation Asset Management, Anita Vandervalk-Ostrander, Joseph Guerre and Frances Harrison, Cambridge Systematics, Inc., Report No. FHWA-IF-03-023, FHWA July 31, 2003.

DDOT administrations – Infrastructure Project Management, Traffic Services, Transportation Policy and Planning, Urban Forestry, and Public Space Administration. Each of these administrations will have ready access to an integrated set of asset data that is tied together via a common location referencing system. They will have access to state-of-the-art analysis, reporting, and mapping tools that draw upon this data set and that will support a variety of business processes, including transportation planning, capital budgeting, capital project management, maintenance and operations management, and Federal reporting.

TEAMS development is to be a "two-tier" process – with one tier being an enterprise-level application fed by data from a variety of business units, and the other tier being asset management applications that meet the specific needs of individual business units, yet are integrated to the extent necessary to support enterprise-wide asset management functions.

Four phases of implementation have been defined for TEAMS:

- Phase I: Feasibility Study and Requirements Analysis;
- Phase II: System Design;
- Phase III: System Development; and
- Phase IV: System Deployment and Implementation.

Phase I of TEAMS includes three tasks: Task 1 is a feasibility assessment that looks at the TEAMS vision and architecture developed to date in the context of business needs articulated by stakeholders, existing and planned systems to support business needs, and commercially available software that might become part of the solution. Task 2 is a high-level functional requirements specification that builds upon the findings of Task 1. Task 3 is a project plan, detailing the activities and sequencing of work in subsequent phases of the project.

1.2 Methodology and Approach

Since TEAMS is planned to be a comprehensive solution, it was determined that a twin track approach to its development is required, combining a "top-down" approach to the enterprise systems analysis and strategy implementation together with a review of asset management practices in each of the main business areas. The analysis starts with the broad vision and sets out to determine how well existing asset management systems fit-in to this. The approach includes the following key elements:

- Broad definition of assets to encompass all physical assets that are part of DDOT's inventory;
- Interviews with stakeholders to determine their data sharing requirements – what data they need from other business units and what data they provide to other DDOT users,

the types of data and applications currently in use, how their business processes interface with other DDOT sections, and what benefits they perceive from the TEAMS concept;

- Review of existing systems including hardware, software, networks, databases, data models and any planned developments that may impact the TEAMS architecture; and

- Review of COTS products and how these map to current asset management systems in DDOT, as well as their ability to be integrated with a solution like TEAMS.

1.3 Document Overview

This report presents the results of Task 1 (feasibility assessment) of the initial phase of TEAMS. Following this Introduction, **Section 2.0** reviews the TEAMS vision, including the proposed systems architecture and concept of operations, the role of the enterprise GIS and data integration methods. **Section 3.0** presents the business case for TEAMS, summarizing the core asset management business needs of the department, the extent to which these are currently adequately supported, and the priorities for improved support as stated by the business owners. **Section 4.0** describes the existing and planned information systems for different core functions related to asset management, and includes summary tables showing the types of data they contain, their hardware and software platforms, who the system users are, and what business functions they support. It also summarizes known deficiencies and future plans for each system. **Section 5.0** presents a matrix of available commercial off-the-shelf (COTS) products that may be considered for the different elements of TEAMS. Finally**, Section 6.0** summarizes the findings of this first task and assesses the feasibility of the TEAMS approach. **Appendix A** is the discussion guide used for the stakeholder interviews. **Appendix B** contains the detailed interview summaries.

2.0 TEAMS Vision

This section reviews the proposed TEAMS architecture, the concept of operations, and how it will deploy GIS and other software to accomplish integration of asset data.

2.1 Architectural Concept

TEAMS is an enterprise solution for data integration related to asset management at DDOT. The TEAMS initial vision recognizes that specialized applications geared to the specific functions and needs of individual business units are required. It also recognizes, however that data pertaining to assets – from their location and characteristics, to the work done to maintain or improve them – is needed by many business units throughout DDOT. TEAMS seeks to ensure that this enterprise-level data can be made available to those who need it, in an easily accessible manner – via map and web-based interfaces.

As illustrated in Figure 2, the TEAMS system, when fully developed, will consist of the following components:

a. A suite of Data Maintenance and Asset Management applications;

b. An enterprise data access middleware tool – SeeBeyond's e*Gate™ Integrator, suitably configured and hosted on a separate Windows 2000 server to provide connectivity and interoperability between applications;

c. An enterprise-level central data repository, with applications for maintenance of the core street system spatial data, and specialized analysis; and

d. A Web Portal which serves as the main gateway for enterprise data access and queries.

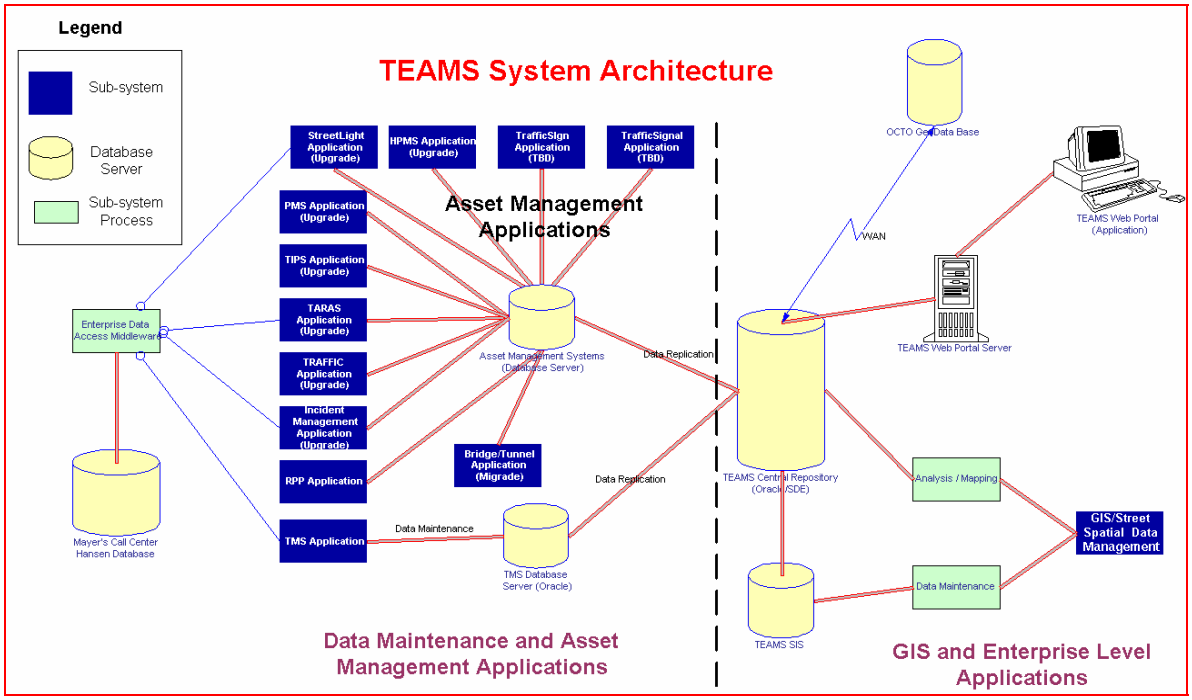
Each of these components is described in further detail below.

Data Maintenance and Asset Management Systems – The TEAMS software architecture is expected to consist of a suite of applications for maintaining information about specific assets; analyzing future needs; prioritizing potential projects; scheduling and tracking both maintenance and capital work; monitoring of traffic, accidents, and incidents; producing the Federal HPMS data; and administering the resident parking program. Currently, the various "transactional" applications exist on a variety of platforms and are comprised of Access, Sybase, Oracle, Clipper and other flat file databases hosted on both servers and desktop machines. The TEAMS architecture, therefore, will comprise a distributed database environment, with a central data repository supporting reporting,

queries and analysis. It also is recognized that, due to data privacy and security issues, certain applications may need to reside on separate, but similar ODBC connected databases and platforms.

Middleware – The architecture presumes that data will be exchanged between some of the data maintenance and asset management databases. For example, if a customer complaint is recorded in the Hansen customer call database regarding a street light, information may need to flow from Hansen into the street light information system in order to establish a work request. Then, when the work is completed, the Hansen database needs to be updated so that the resolution of the complaint is recorded, and the Mayor's scorecard system can include this action in its performance reporting. It is envisioned that this kind of event-driven workflow will be implemented to provide seamless integration across systems. These data exchanges are likely to be accomplished using e*Gate Integrator, which will be hosted on a separate server (not shown in Figure 2).

Figure 2. TEAMS Vision



TEAMS Central Repository – The TEAMS Central Repository will serve as a data warehouse for the GIS and the linear referencing system. It will have front-end web/application server(s) to host the TEAMS web portal, which will serve as the main gateway for enterprise data access and data query. This database will have two-way interaction periodically with the following systems:

- Asset Management Application Databases;
- Traffic Monitoring System (TMS) Database;

- Street Information System (SIS) Database; and
- OCTO GIS Database (via WAN).

The interactions are necessary for transactional information to be replicated to the data repository, and for synchronizing updates between DDOT's GIS and the OCTO Geodatabase. The GIS will provide a number of functions, including:

- Map-based Graphical User Interface (GUI) to query asset data by location;
- Integration of the road centerlines, other spatial data, and asset features in a geodatabase;
- Management of the linear referencing system with query and analysis tools;

The interactions among the various databases outlined above will be accomplished through a combination of database replication, custom code and the e*Gate Integrator middleware.

The TEAMS central repository does not have any operational functions beyond data integration; these operational functions (i.e., data maintenance and asset management applications) remain with the business owners.

TEAMS Web Portal – The TEAMS Web Portal will provide enterprise-wide access to data in the central repository. It is anticipated that this will include for map-based query and display, as well as access to standard tabular reports.

2.1.1 TEAMS Asset Management and Enterprise GIS Subsystems

The components described above can be categorized into two main subsystems; the Asset Management Applications subsystem and the Enterprise GIS subsystem (see Figure 3). TEAMS is an ambitious project with a number of complex features. In order to manage the complexity, it is recommended the TEAMS concept of operations be described as two subsystems that will foster data integration internally and externally. In this way, the design and development can be divided into manageable pieces, always keeping in mind the ultimate vision of a fully integrated system.

The feasibility (and ultimate success from a technical standpoint) of TEAMS will be affected by the level of data integration to support business processes *within* each subsystems and *between* the two subsystems.

In the Asset Management subsystem, the middleware software will play the role of data broker between the databases and applications, while in the Enterprise GIS subsystem, location is the common denominator. Currently the two subsystems are somewhat independent with ad hoc interfacing between the applications and the GIS. The TEAMS goal is to break down these barriers and create synergy between the two subsystems. For example, when the TEAMS vision is realized, asset management applications should contain the SIS ID, which will enable mapping of their data in the GIS. Similarly, the

TEAMS geodatabase will contain foreign keys to the asset management databases, enabling synchronization between the spatial features and asset management data.

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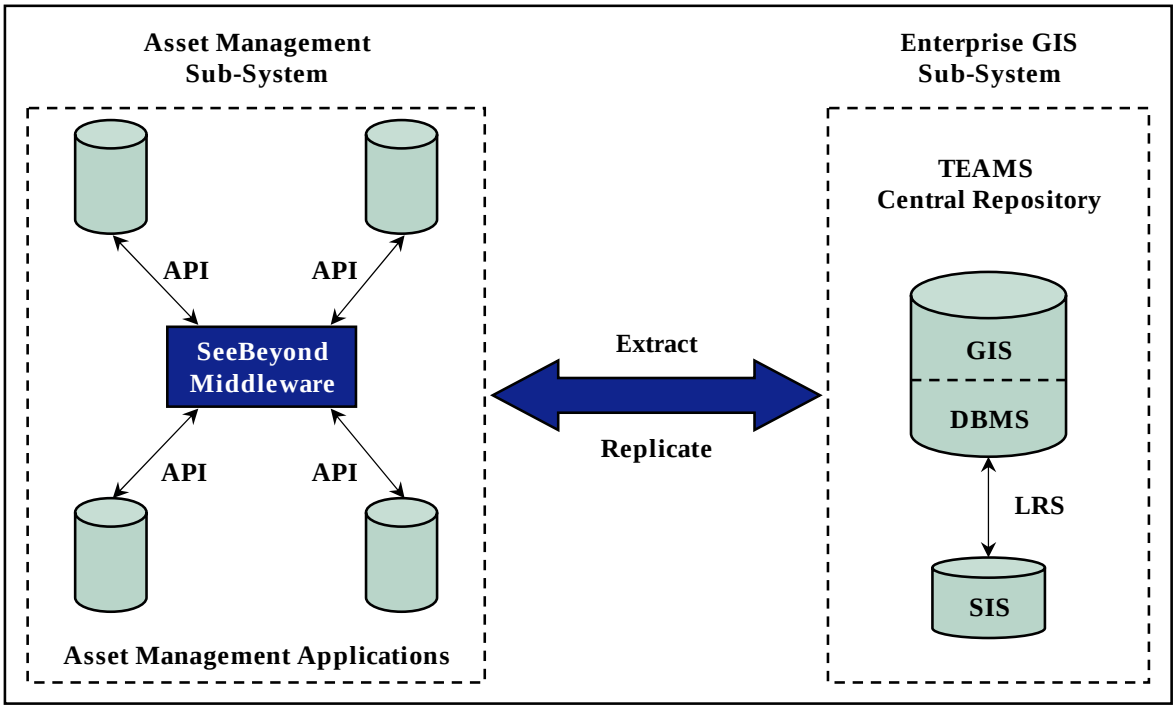
Figure 3. TEAMS Subsystems



2.1.2 IT Infrastructure

Of the various systems mentioned above, the OCTO Geodatabase will be accessed via the D.C. WAN since it is located at a remote location (Judiciary Square) on OCTO servers, while the Hansen Call Center Database and other TEAMS applications located at the DDOT in-house data center at the Frank E. Reeves Municipal Center, will be accessed via the DDOT LAN. Some of the TEAMS application components located at remote DDOT

locations will be accessed via the DDOT WAN via Frame Relay T1, SMDS,[1] and redundant ISDN circuits.

DDOT currently has its own data center, shared with the Department of Public Works (DPW) at the Frank E. Reeves Municipal Center. While the two departments are currently in the process of splitting their IT infrastructures so as to be completely independent of each other, it is expected that they will both continue to host their respective infrastructures within the same data center.

It is intended that the new TEAMS application servers, and associated middleware servers, also will be hosted out of the same data center. However, Internet connectivity will continue to be provided through OCTO's D.C. WAN infrastructure, via fractional T3 and redundant T1 circuits. The TEAMS applications, hosted at remote DDOT sites and remote DDOT clients, will be connected via the DDOT frame relay cloud.

2.2 Enterprise GIS

The GIS plays a central role in TEAMS, acting as the data broker between the asset management databases and the spatial data warehouse. An enterprise GIS needs a number of components:

- GIS program and relational database management system;
- Spatial data – the transportation network;
- Linear referencing system – support multiple linear referencing methods; and
- An enterprise geodatabase model to integrate the spatial data, the linear referencing system and the business data in the asset management programs.

2.2.1 Core Technology

DDOT has adopted Oracle and ESRI as the primary software vendors to support the Spatial Data Services:

- Oracle 9i as the enterprise relational database management system. (DDOT will support other databases that ESRI can work with such as Access and SQL/Server but Oracle is the enterprise database of choice for the TEAMS project);

[1] At least one SMDS circuit owned and operated by OCTO connects to a remote DDOT application user location.

- ArcSDE – ESRI's Spatial Data Engine for managing spatial data in a database server;
- ArcGIS suite of products as the GIS toolkit for users (ArcMap, ArcEdit and Arc/Info);
- ArcIMS as the Internet map server for Web-GIS access; and
- ESRI's Geodatabase model for managing the spatial and attribute data in the enterprise database.

ESRI's technology continues to evolve to work more closely with web-based services on multiple platforms (Windows, Unix and Linux). While not entirely open, the convergence of GIS and IT standards is providing more flexibility and options for the TEAMS development. For instance, Java-based maplets such as MapObjects may be an option to consider in combination with ArcGIS Server rather than ArcIMS, which has somewhat limited customization capabilities. Alternatively, ArcIMS version 9 (expected to be released in 2004) promises to have additional capabilities (including linear referencing) that could be combined with ArcGIS Server to provide enhanced tools to the user. The choice will be influenced by performance and cost, but at least DDOT can be reassured that the technology is moving in the direction needed to support the TEAMS concept of operations.

2.2.2 Location: The Common Key

There are two common denominators to the management of most enterprises – money (how much does it cost?) and location (where is it?). The common monetary currency is the dollar, and it would seem odd if different departments in DDOT used different currencies to pay their bills and their staff. Yet, paradoxically, this is the situation with regard to location. While a location referencing "currency" exists in DDOT, namely the Street Inventory System, not everyone uses it and, in some cases, alternate location methods are employed. Consequently, location often has to be converted or interpolated based upon some known reference points. As with any currency exchange, this has a cost and is subject to external factors such as data accuracy.

A key goal of the TEAMS concept is to establish location as a common key that can be easily used by the different databases and applications. Location is most easily managed in a Geographic Information System (GIS) that provides mapping capabilities to show where assets are located. GIS is an important tool for TEAMS, but a distinction needs to be drawn between location as the common data denominator and GIS as the asset data manager. GIS can help to locate features such as assets, but the management of assets is the responsibility of the business units. This point is emphasized here, as there is a common misconception that once location is managed by GIS, the GIS takes ownership of the business data. Technologies are now available that allow geographic or location-related data about assets to be managed separately from other kinds of information (condition, work history, etc.). Thus, the GIS function is to support business areas by providing a common geographic referencing method and set of tools. This distinction is key to establishing the role of GIS in the TEAMS enterprise solution.

2.2.3 Linear Referencing Methods

One the most important tools that GIS provides is the ability to manage linear referenced data and transform the data between linear referencing methods. DDOT business units and applications utilize a number of linear referencing methods, including:

- The Street Inventory System (SIS) which references data by street segment and distance measure along the segment. The SIS is DDOT's primary linear referencing method used in several applications and is described in detail below.
- Street addresses – data is geocoded to the street name and address range.
- Latitude/longitude or x,y,z coordinates as determined by GPS.
- HPMS sections that reference longer segments of roadway (concatenation of SIS segments).
- Route-based measures such as pavement sections along named streets (distance offset from the beginning of the route).

As long as these methods reference the same underlying street network, it is relatively straightforward to toggle between them. For example, a location determined by GPS can be positioned as a measure along a street segment or named route. Similarly, the GIS can derive the x,y coordinates of any location along a street segment. Figure 4 in Section 2.2.5 below illustrates how correspondence is established between the GIS street network and the linear referencing methods.

2.2.4 Street Inventory System

DDOT'S Street Inventory System (SIS) was originally designed over 30 years ago as a system to maintain roadway data. All of the SIS data maintenance modules are designed around a master geography file, which provides a common geographic referencing method. Over the years, many components have been added to the tabular system that includes modules for administrative classifications, pavement characteristics, pavement condition survey results, sidewalks, curbs, traffic, transportation improvement projects. The current SIS is based on old, pre-Windows (and pre-GIS) technology – it was written in Clipper to run under DOS on a Novell network.

The department initially developed a geometric network of the street centerline using TIGER data and data from the SIS. Under an agreement with the National Capitol Planning Commission and other District Agencies, DDOT set out to develop a more accurate, complete GIS within the District. This initiative created centerlines for streets, ramps, alleys and service roads. The street centerlines were developed from the planimetric data from 1999 imagery. Single centerlines were created for all segments of streets within the District, except for divided highways, and other streets identified by DDOT, such as Kenilworth Avenue. In these cases, dual centerlines were created. Recognizing that very

few segments other than street centerlines had a SIS code, unique codes were developed using the SIS as to identify a particular segment of ramp, alley or service road. An ArcInfo coverage was created with tabular files that could be stored in the SIS. For the street centerline coverage, directionality, lane usage, street name, curb type and address ranges were updated between cross-streets.

Currently the GIS group are developing a new street centerline transportation data model that will help support the migration from the old file system to a RDBMS-based spatial data server. This new system will be a ESRI geodatabase residing on ArcSDE 8.3 and Oracle 9i.

Immediate and future benefits derived from an integrated SIS and GIS include:

- A complete inventory and accounting of GIS centerline data;
- Determine accuracy and standards for spatial data requirements;
- Future GIS data development based on an enterprise data model;
- Provide the foundation for control and development of other GIS-related functions;
- Foster closer cooperation with other District agencies such as OCTO who manage the District's base map;
- Promote application development utilizing feature overlays;
- Cost savings by managing the data in a single integrated environment; and
- Utilizing LRS as a link for data integration and transportation analysis.

2.2.5 Transportation Geodatabase Model

One interesting development that is important to the TEAMS implementation is the improvements in GIS in the area of linear data management (e.g., for roadway networks). While GIS have had the capability to perform linear referencing and dynamic segmentation since the early 1990s, until the latest versions these functions had to be customized to the user's requirements. Some customization is still required, but the geodatabase and the latest tools for linear event processing make this a lot easier and provide more options for how DDOT wishes to utilize asset management programs in the future. Specifically, many asset management products include spatial data modules for linear data management, but it may be more efficient and cost-effective, to manage this aspect within the TEAMS GIS environment. The GIS staff have considered this issue in their geodatabase design, as described below.

The conceptual transportation geodatabase data model design has four data levels that include:

- A **Base Reference Network** based on road geometry and including all road features such as streets, alleys, driveways, street intersections, metro stations, park-and-ride lots, etc.;

- An **Application Reference Network** which is the street centerline network for specific applications, such as the SIS or routing;

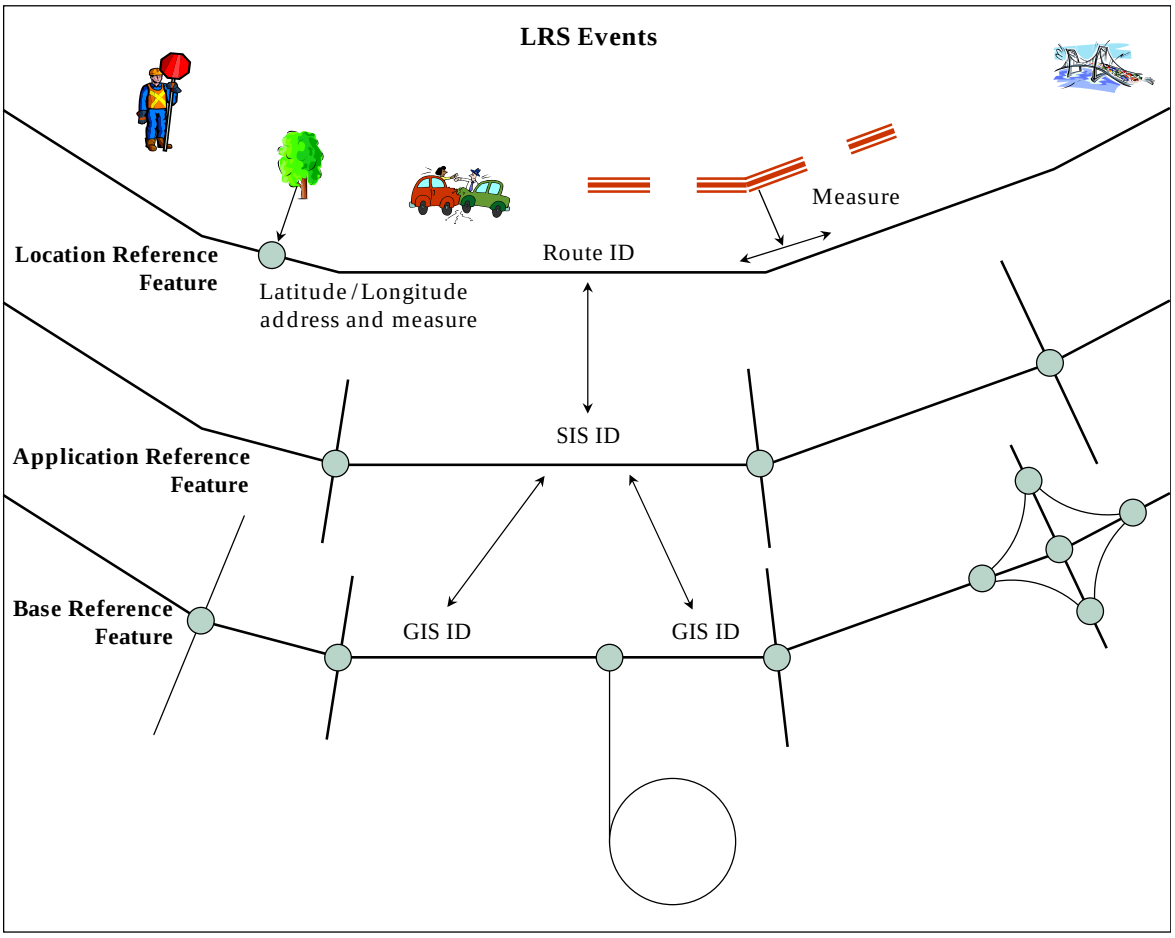
- **Locational Reference Features** are routes set-up to locate features based on measures (e.g., SIS distance from intersection) or other location method (street address, latitude/longitude). An example is the Cityworks tree application; and

- **Data Events** like accidents, traffic counts and assets, which may be point or linear features.

The geodatabase model ties these levels together and manages them as an integrated system. For example, changes in the base map such as the addition of new city blocks automatically update how the data is referenced in the other layers. Most users will interface with levels three and four; levels one and two will be edited by the GIS staff. Figure 4 depicts the relationship between the four levels.

The geodatabase model being developed by the GIS staff uses the latest capabilities from ESRI and is somewhat leading-edge in this respect. In theory, the geodatabase provides a robust environment for managing the relationships between the various features and event data, including the ability to toggle between linear referencing methods such as latitude/longitude, street address and SIS measurements. In practice, setting-up the geodatabase requires migrating the existing coverages and attribute data into the geodatabase environment and optimizing the data model to manage what will be a large volume of data. In addition, the geodatabase will need to include entities that provide hooks to the external asset management databases. Without going into the design details – a phase two task – it has to be recognized that setting-up and managing an enterprise geodatabase is not a trivial task and requires significant resources and skills from specialists in GIS and database management systems. The GIS staff are already supporting a number of day-to-day programs as well as other business development activities, and this factor needs to be taken into account in any TEAMS development.

Figure 4. Transportation GIS Networks



(Figure adapted from presentation prepared by DDOT OSAT Spatial Data Systems Group.)

2.3 Data and Application Integration

TEAMS is concerned with both data and applications integration. Data integration allows for queries to include data from multiple sources.

While location is a critical factor in data integration, location is not always the key by which information is queried. Users may be more familiar with project numbers or some other identifier, the location may not be known and, even if it is, users may know the data they are looking for, they just need a method to get access to it. A map interface is a useful device for these types of queries, but not in all situations. Other techniques such as web browsers that enable searches and navigation, may be just as useful. The web model of data query has changed the way that people think about data and how to get access to it.

Before the Internet, data was stored in proprietary databases and applications, and enterprise solutions meant re-engineering business processes to enable data sharing.

The web-based services model does not require any major re-engineering (although updating business processes to take advantage of data sharing capabilities is highly recommended). However, some changes in databases and applications are required if this arrangement is to succeed. Specifically, they must be more open systems with an Application Program Interface (API) that can exchange data with other systems, and they must be able to work with the TEAMS location referencing methods; that is, the API should interface with DDOT's GIS software. Currently, not all databases and applications in DDOT meet these requirements, as described in later sections of this report.

DDOT's approach to enabling data sharing on a web-based model is to implement a "middleware" solution, so called because it acts as a bridge between disparate databases and applications. The middleware approach to systems integration has become popular with the growth of the Internet, and middleware software can work on both Internet and intranet local area networks (LAN) and wide area networks (WAN). Middleware works by providing exchange protocols between different data formats. For example, users with the appropriate security privileges can view data held in another database without having the database or application on their desktops. They can even copy data to their own computers and enter it into a suitable program, for instance copying data from an Excel spreadsheet into an Access or Oracle database.

DDOT has selected an enterprise data access middleware solution from SeeBeyond Inc. called e*Gate™ Integrator (part of SeeBeyond's Business Integration Suite) to provide these capabilities. e*Gate Integrator relies upon the databases and applications having an API that it can read and write to. Presently, the department has yet to deploy e*Gate Integrator and, therefore, it is difficult to gauge how many of these will be able to communicate via e*Gate Integrator. e*Gate Integrator can exchange text-based location information such as a street address, latitude/longitude or a distance measurement from an intersection, but it cannot exchange spatial data with the GIS. As currently configured, e*Gate Integrator would work in parallel with, but separately from the GIS in the TEAMS enterprise solution. Therefore, the data integration will be accomplished by two methods, one via the middleware software of e*Gate Integrator and another via the GIS. An interesting question for the TEAMS development is to what extent these two systems should be integrated? A more integrated solution may be feasible with web services,[2] which can manage geospatial data as well as alpha-numeric text and images. This is an issue to be studied in the detailed TEAMS system design in the next phase.

[2] A Web Service is defined by the W3C as "a software system designed to support interoperable machine-to-machine interaction over a network."

3.0 TEAMS Business Case

This section summarizes the results of stakeholder interviews, presents the business case for TEAMS, and summarizes gaps to be addressed with TEAMS implementation based on the business case analysis.

3.1 Methodology

The business case analysis is based on interviews with over 30 stakeholders across all five DDOT administrations, and within the Office of the Director. The stakeholder interviews were designed to identify and prioritize specific business needs to be met from the TEAMS implementation. These needs will provide important inputs to the Task 2 high-level requirements analysis. While the interviews covered a wide range of topics related to each stakeholder's work processes, the focus was on *enterprise* data needs and applications as opposed to data and applications that do not need to be shared across multiple units.

Stakeholders interviewed are listed in Table 1. In addition to those listed in the table, interviews were held with contractors working on the AASHTO Trns*port implementations within DDOT.

A detailed interview guide was prepared to ensure consistency across the different interviews. This guide is provided in Appendix A.

Table 1. Stakeholder Interviews

Administration/Division	Stakeholder(s)
Transportation Policy and Planning Administration (TPPA)	• Ken Laden (Associate Director) • Emeka Moneme (Capital Budgeting) • Alex Eckmann, Gilbert Williams (Office of Mass Transit)
Infrastructure Project Management Administration (IPMA)	• John Deatrick (Associate Director) • Mesfin Lakew (Asset Management Division) • Donald Cooney (Asset Management – Bridge and Tunnel) • Simon Rennie and Greg Marshall (Asset Management – VMS) • Derege Seifu (Asset Management – Pavements) • Serge Louis (Contract Management) • Sylvester Okpala, Abdullahi Mohamed (Project Team Supervisory Civil Engineers) • Konjit Eskender, Samuel Olatunji (Project Team Design Engineers)
Traffic Services Administration (TSA)	• William McGuirk (Associate Director) • Abdul Sleemi (Traffic Safety) • Peter Moreland (Traffic Safety – Data Analysis) • Jean McCall and Anthony Jackson (Curbside Management) • Kamal Hamud and Kim Walker (Signal Systems) • Narul Haque, Abdullah Fatah, Michael Dorsey (Electrical- Street Lights, Permits & Investigations)
Public Space Management Administration (PSMA)	• Lars Etzkorn (Associate Director) • Daniel Harrison (Inspections) • Denise Wiktor (Permitting) • Robert Marsili (Bridge and Street Maintenance)
Urban Forestry Administration (UFA)	• Ainsley Coldwell (Associate Director) • Wanda Polite (Program Support)
Office of the Director – Operational Support and Applied Technology (OSAT)	• Jerryl Trammell (Chief Technology Officer) • Gus Viteri, Leela Bharani (Applications Support) • Minhua Wang, Ali Fatah, Markos Yeterawork (Spatial Data Systems) • Samuel Kolbe, Shaara Kindermann, David Pearson (Electronic Document Management)
Office of the Director / Other	• Michelle Pourciau (Strategic Planning) • Karen Benefield (Neighborhood Services) • William Lewis (Office of the Chief Financial Officer – Budgeting) • Ginny Grant (Office of the Chief Financial Officer – Assistant Controller / GASB34 Reporting) • Jerry Carter (Contracting Officer)

3.2 Interview Findings

A summary of each stakeholder interview was prepared and organized according to the following categories:

- Key activities;
- Enterprise data needs to support asset management activities (i.e., data needed from other units);
- Enterprise data produced (i.e., data of potential interest to other units);
- Current and planned applications; and
- Automation needs, issues and opportunities.

A summary of each of these items for each interview is presented in Appendix B. Table 2 summarizes the core asset management data needs, the business case for these data needs as expressed by stakeholders, and gaps between the needs and the TEAMS vision. Both data and business process gaps are included, since improving existing processes for collecting, updating, using and sharing data will be essential for realizing the TEAMS vision.

As shown in the table, enterprise data needs include relatively static physical characteristics of assets (e.g., locations of bridges, street lane and shoulder widths, sidewalk and curb types, tree locations and species); dynamic characteristics that are tracked on a regular basis (e.g., pavement condition, accident rates, daily traffic); and information pertaining to the need for and accomplishment of work to repair, rehabilitate, improve or replace assets.

Table 2. TEAMS Enterprise Data Needs, Business Case and Gap Analysis

Asset Management Category	Enterprise Data Needs	TEAMS Business Case	Business Process and Data Gaps
Asset Location, Characteristics, and Condition	Minimum enterprise information includes location (common geographic referencing) to allow for GIS mapping; classification and dimensional information, and age or condition assessment; level of detail varies by asset type. Asset types include: - Roadway / Pavement - Bridges - Tunnels - Culverts - Alleys - Sidewalks - Curbs - Retaining Walls - Impact Attenuators - Traffic Signals - Street Lights - Signs - Trees	• Foundation for diverse set of activities: capital planning, project prioritization, customer complaint tracking, maintenance management, design & construction, operations, safety improvements, linking work histories and expenditures to specific assets • Enterprise approach could allow for economies in data collection – program could be designed to update condition information for multiple asset classes; also would allow for basic data to be checked / verified by maintenance, traffic, design / construction personnel while in the field	• Current inventory data not available for retaining walls and impact attenuators; data for curbs and sidewalks is old and incomplete. • Current efforts will provide inventory data for alleys and culverts, though location referencing for these assets is yet to be specified. • Integration of bridge location information with SIS ID-based information (e.g., for HPMS) has proved difficult. Need to include more precise start and end points of bridges – e.g., intersection + offset distance. • Sign information exists but on paper logs. • Regular, well-defined processes for inventory updating and condition assessment not in place for assets other than pavements and bridges.

Table 2. TEAMS Enterprise Data Needs, Business Case and Gap Analysis (continued)

Asset Management Category	Enterprise Data Needs	TEAMS Business Case	Business Process and Data Gaps
Street / Route Classifications	Functional Class Ownership / Maintenance Responsibility NHS status Bus Routes Snow Plow Routes Emergency Evacuation Routes	• Required by multiple business functions: planning, maintenance, HPMS / Federal reporting, traffic monitoring, capital planning, design / construction	• Data ownership for these items has not been formally assigned; need clear process for updating. • Functional class, NHS status and ownership are key HPMS items and need to be kept accurate. • Information is currently maintained in SIS, which has limited validation and visualization tools to ensure data accuracy.
Street Configuration and Operational Characteristics	Lane configurations Shoulder Type & Width Median Type & Width Intersection Traffic Control: Signalization, Signage, Turn Prohibitions	• Needed by traffic services, neighborhood planning, pavement management, design & construction, maintenance	• Lane configuration, shoulder and median information exists in SIS but is not regularly updated. Units outside of IPMA generally unaware of this data source. • Intersection information not complete and not shared across units. • No clear ownership or well-defined processes for updating these items.

Table 2. TEAMS Enterprise Data Needs, Business Case and Gap Analysis (continued)

Asset Management Category	Enterprise Data Needs	TEAMS Business Case	Business Process and Data Gaps
Traffic	AADT by location and year (map) Traffic by vehicle class Pedestrian counts HPMS-required traffic data Federally required traffic monitoring data Turning movement counts for traffic studies, improvement designs, signal timing Factors for capacity / service calculations (e.g., percent trucks, peak-hour factor) Time series / trends	• Traffic and pedestrian counts are key inputs to several processes, including project scoping, priority-setting, benefit / cost analyses, project design, work zone safety measures, pedestrian safety measures, neighborhood planning efforts, traffic regulation development, traffic operations, etc. • Inclusion in TEAMS would facilitate Federal HPMS reporting process (along with business process improvements and Traffic Monitoring System to ensure timely and quality data)	• Problems with traffic counters have created gaps in data coverage and accuracy. • Traffic data entry and processing procedures are not automated; raw data maintained in isolated spreadsheets • Creation of AADT map is a heavily manual process; not taking full advantage of existing GIS data and technology. • No standardized process exists for sharing of traffic counts across TSA and TPPA. • Many of these issues are addressed in Traffic Monitoring System (TMS) recommendations.
Safety	High Accident Locations Identified countermeasures and their status Time series / trends	• Enterprise access to accident information would support integration of safety considerations in the full spectrum of design, construction, operations, and maintenance activities. • Would enhance coordination between TSA and other administrations	• Lack of electronic accident reports from police creates need for time-consuming manual entry of accidents. • Current method for locating accidents is based on a block identification; mid-block accidents cannot be distinguished from accidents occurring at intersections • Accident data not easily accessible on an enterprise-wide basis.

Table 2. TEAMS Enterprise Data Needs, Business Case and Gap Analysis (continued)

Asset Management Category	Enterprise Data Needs	TEAMS Business Case	Business Process and Data Gaps
Work History by Work Type, Asset and Location	Work Type (maintenance and capital) Date Cost – total and by work type Links to project & contract information As-built drawings (for construction projects)	• Valuable information on costs and performance / effectiveness of different treatments – important input to asset management, correlation with condition information • Historical split of work on different assets needed for updating of composite depreciation rate used for GASB34 • Useful to strategic planning and capital budgeting process – understanding of costs by work type, asset and location • Project completion dates needed for identification of street cut moratorium period • Useful for communication with customers	• Project location information is not consistently described across systems. • Existing processes for creating and tracking project information do not allow for direct comparison across planned and historical / trend work • Existing processes do not allow for splitting out planned or historical work and costs by asset type and route or zonal location.

Table 2. TEAMS Enterprise Data Needs, Business Case and Gap Analysis (continued)

Asset Management Category	Enterprise Data Needs	TEAMS Business Case	Business Process and Data Gaps
Planned and Active Capital Projects (local and Federally funded; including signal and street lighting work)	Locations Milestones and status (cradle to grave) Estimated and Actual Costs by activity / work code (including utility support) Exceptions / Change Orders Work types included (e.g., does project involve electrical work)	• Need to identify project locations at project initiation, and split project work by asset class and location for tracking purposes – this would allow for mapping of capital project locations, which would be useful for a variety of purposes: customer communications, neighborhood planning, capital planning and project scheduling, coordination with utilities • Stakeholders need to find all planned work by location, regardless of funding source (Federal versus local programs) • Current (updated at least weekly) project status information needed for multiple stakeholders – both future programmed and active projects • Clear understanding of milestones and assigned responsibility, with automatic notification would facilitate more efficient work flow • Identification of projects involving electrical work would facilitate coordination between project teams and electrical inspectors	• See comments above regarding Work History • Processes for sharing of project information are currently manual; no automated updates across systems occur. Lack of consistency in project identifiers and data structures is one factor limiting data sharing. • Processes for updating capital project status information and making this widely accessible are not well-defined or automated.
Short-Term Work Schedules	Activity, Location, Date	• Improved coordination of work (including inspections) across units; opportunities for piggybacking of multiple types of work in a single location • Resource for public inquiries	• Work scheduling / dispatching processes within individual units are typically paper-based and not easily shareable, making coordination difficult.

Table 2. TEAMS Enterprise Data Needs, Business Case and Gap Analysis (continued)

Asset Management Category	Enterprise Data Needs	TEAMS Business Case	Business Process and Data Gaps
Utility construction plans / schedules	Utility, Location, Date(s)	• Improved coordination between utility work and DDOT construction work; minimize user disruption, maximize value gained from work	• Data gaps exist with respect to easily accessible information on underground assets • Mapping of planned utility work has occurred in order to facilitate coordination with construction, but some units were not aware of this information.
Permits	Type, Location, Milestone / Status history	• Traceability of permits across different project work phases would enhance work efficiency and effectiveness • Electrical division needs to know about permits issued for subsurface work. • Useful for neighborhood liaison	• Lack of accurate and complete location information on some permits limits potential for map-based queries / reports of this information • Currently multiple systems for managing and tracking permit process; duplicative effort involved • Enterprise-wide access to permit information does not exist.
Work Requests / Trouble Ticket (cross functions)	Location, Issue / Problem, Source, Suggested Resolution, Status, Date, links to correspondence and work history	• Centralized, standardized method for tracking work requests and their resolution would improve coordination across business units where dependencies exist and could improve efficiencies • Summaries useful for executive oversight, performance reporting, customer relationships	• Several applications are used; no automated processes in place to transfer information across systems.

Table 2. TEAMS Enterprise Data Needs, Business Case and Gap Analysis (continued)

Asset Management Category	Enterprise Data Needs	TEAMS Business Case	Business Process and Data Gaps
Deficiencies / Needs	Location, asset type, deficiency type, recommended solution, date observed, source	• Centralized file of deficiencies from multiple sources (including unresolved customer complaints, neighborhood studies) would be valuable for coordination of work, development of capital, operational, and maintenance strategies that address multiple needs at a given location.	• Processes and systems not in place for standardized approach to identifying deficiencies across asset types; systems not in place to consolidate this information from individual asset management systems.
Asset Management Planning Parameters	Unit costs for different treatments (replacement, rehabilitation, repair) Remaining life after different treatments Mean time to failure after replacement (for certain types of assets) Standard economic assumptions (inflation, discount rate, user costs)	• Provides consistent method for developing preventive maintenance strategies, selecting least life-cycle cost investment strategies, allows for comparable analysis and tradeoffs across asset classes, used in project design • Enterprise approach required to develop and refine these estimates over time based on tracking of deterioration trends, work history and costs	• This has been done for individual assets (e.g., pavements), but consistent approach across assets has not been addressed, and ongoing connections to project history and historical inspection data have not yet been made.
Performance Measures	Weekly / monthly activity summaries Annual condition snapshots	• Required for strategic planning & management, customer relationships	• Current process for performance measure summaries based on manual compilation of data from multiple systems
GIS land / parcel information	Underground utilities (location and type) Right-of-way distribution Parcel ownership Premise Addresses Historic Sites Flood-Prone Areas	• Multiple uses for this information: permitting, design and construction, maintenance management, customer relationships	• Right-of-way and underground utilities information were the most commonly cited GIS data gaps to be filled.

Table 2. TEAMS Enterprise Data Needs, Business Case and Gap Analysis (continued)

Asset Management Category	Enterprise Data Needs	TEAMS Business Case	Business Process and Data Gaps
Curbside Regulations	Resident Permit Parking # parking spaces by type and location metered / unmetered, time-restricted, special purpose (e.g., loading zone, taxi stand)	• Useful for parking management, neighborhood planning	• This information is paper-based; limits ability to link to other data.

3.3 Conclusions

TEAMS Business Case

Stakeholder interviews provided numerous examples of how development of an enterprise database with GIS and web applications providing access to this information could help to meet several key business objectives:

- *Improving coordination of work* across different business units responsible for the same assets. This coordination ensures that multiple perspectives and areas of specialization throughout the Department are brought to bear in the planning and conduct of work, that work activities are planned considering all known needs and deficiencies which may exist at a given location, and that work flow processes involving sequences of actions across multiple units occur efficiently without disconnects. Examples include managing and tracking responses to citizen complaints, approval and tracking of capital projects throughout their life cycle, and coordination of specialized analyses and inspections (e.g., safety, electrical inspections) with maintenance and construction work. Coordination with outside contractors that perform much of DDOT's maintenance work (e.g., for street lights) has posed a particular challenge, since they typically have their own internal work tracking and management systems that are difficult to interface with DDOT's systems.

- *Improving convenient access to timely and accurate* information about asset condition, characteristics, capital project or maintenance work activity status, available in a highly accessible fashion to DDOT decision-makers and individuals responsible for interagency liaison and communication with the public. Because information is currently fragmented and not systematically recorded in an easily query-able form, it is

difficult and time-consuming to obtain answers to questions that arise on a variety of issues.

- *Developing a strong, credible base of integrated information* to enable better decision-making with respect to priority-setting, asset maintenance standards and policies, and optimal means and methods for work. Representatives of both IPMA and PSMA view this as a key benefit to be gained from TEAMS. Several stakeholders expressed an interest in developing stronger preventive maintenance programs to extend the life of assets and thereby reduce capital needs over the long term. Stakeholders also noted that much of DDOT's work is complaint-driven; whereas perhaps a more proactive approach of planned replacement (for lower-cost assets such as street lights) would serve customers better. Gathering of data on costs and performance (condition trends, time to failure) is invaluable for development of cost-effective preventive maintenance and planned replacement programs. Much of this functionality is by nature built-in to individual asset management systems. An integrated approach can emphasize consistency across applications and can provide the ability to facilitate tradeoffs across assets and investment types.

- *Facilitating performance measurement and management reporting* functions; both by further automating consolidation and reporting of existing performance indicators and also potentially making new, more meaningful indicators available (through integration of information from disparate sources).

- *Facilitating the efficient and accurate preparation of external reports* that draw upon a variety of sources (e.g., HPMS).

Gap Analysis

As seen in Table 2, there are both data and business process-related gaps to be addressed as part of TEAMS implementation. Key gaps include the following:

- Lack of inventory data in electronic form for some assets (e.g., retaining walls, signs);

- Lack of agreed-upon specification of standard geographic referencing methods for several asset types (e.g., bridges, culverts, alleys), and for event-type information such as permits and accidents;

- Lack of clearly specified ownership for all data elements, and well-defined processes for data updates;

- Lack of ability (in both data structures and processes) to connect asset information across different life cycle phases, from planning to project development, design, construction, and work history;

- Lack of processes and systems to facilitate sharing of information across functional silos (traffic / design and construction / maintenance);

- Lack of ability to easily summarize planned and historical work by location and asset class – (again, due both to data structures and processes);

- Fragmentation of work tracking systems, making it difficult for multiple units (and outside contractors) to coordinate, update status information. This also complicates performance tracking processes;

- Time-consuming, manual processes for data entry / updating and summarization – particularly within TSA for traffic and accident data; and

- Limited use of GIS tools beyond mapping – untapped potential exists for increased use of these tools for ad-hoc querying, data validation, and specialized applications including preparation of traffic flow maps, work dispatching, and routing.

Common Application Needs

Application needs common to several business units included the following:

- GIS capability to map multiple data sources (selected by the user);

- GIS capability to retrieve asset, project, activity, work history data for a selected location;

- GIS interface into data entry / updating screens for individual assets or work tracking;

- Capital project work flow automation (from planning through closeout);

- Capital project status tracking;

- Work history and expenditure query capability (to retrieve information by location, type of work, type of asset);

- Standardized or integrated maintenance management / work order / activity tracking systems across units and outside contractors;

- Standardized or integrated permit tracking systems across units;

- Executive information system – performance reporting (synthesis from multiple source systems); and

- Field data collectors with GIS and GPS location capabilities – for condition assessment, field work recording, problem / issue reporting.

Some of these features have been defined as enterprise-level applications (such as the GIS-based query capability); others are worth noting here for consideration given that many of the legacy applications are candidates for replacement. The strategy for replacing some of

these applications can take advantage of significant opportunities for cost-effective application sharing across units.

3.4 Implications for TEAMS Implementation

It is clear from the business case analysis that TEAMS can offer significant benefits to DDOT, including providing an improved basis for asset management decisions, and improved coordination across different business units which can yield better customer service, more efficient use of resources, and better asset performance. In order to maximize the potential benefits of TEAMS, a number of both technical and organizational steps need to be taken in subsequent phases of the project. Tasks 2 and 3 will address implementation considerations in a more comprehensive fashion; a preliminary list is provided below:

- Address business process and organizational impediments to data sharing, which is a major, yet critical undertaking essential to TEAMS success.
- Address data ownership, quality standards, and efficient data collection methods to ensure that information in TEAMS is complete, credible and timely.
- Where work flow automation is to be implemented, make appropriate changes to business processes to take full advantage of the automation, and ensure that business processes and responsibilities for each step are well-documented.
- Ensure that common location referencing methods are used in all individual asset management and related systems.
- Identify and break down all work activities (maintenance and capital) by the asset category – a standard set of asset codes will need to be developed.
- Develop (and obtain agreement on) a shared hierarchical coding method for work types across all assets that allows for high-level rollups of work types across different asset classes. Ensure that work type designations utilized in individual asset management systems are compatible with (i.e., can be translated to/from) this method.
- Develop and maintain "crosswalks" between project information and financial information identifiers to facilitate linkages between planned work and budgets.
- Establish and maintain a corporate data model to ensure consistent treatment of the same "entities" across different systems.

4.0 Existing and Planned Applications

This section describes the existing and planned applications related to asset management in DDOT. Information on these was provided by stakeholders interviewed for this project and by staff from OSAT.

4.1 Overview

Information was collected on applications that are either currently in use (including those that are to be replaced), planned for future implementation, or in the testing stage. The applications covered here comprise only *formal* systems that are generally (although not always) used by more than one DDOT division, and which already share information and data across divisions or have demonstrated a need or potential for data sharing under the TEAMS framework. It should be noted, however that this compilation is not an exhaustive list of all systems within DDOT, which also encompasses *informal* systems developed by various divisions to support their own individual business processes. An example of this type of application may be an internal project tracking system, typically enabled by desktop Microsoft Office software such as Excel or Access, which resides on individual desktops and whose output does not feed work flow of other divisions.

Tables 3 through 5 (at the end of this section) display the systems, organized by status (existing, in testing, and planned) and contain information including: business area processes supported by the application, system users, application type (whether "in-house," "commercial," or "external system" which resides outside of DDOT but which division staff need to input or update), future system development plans, vendor information, underlying database, application language, operating system, location referencing capability, and any applicable comments.

The remainder of this section provides descriptions of these current and planned systems in the context of the types of enterprise data they contain and the types of activities they support. This information facilitates a comprehensive understanding of the data and functionality that may potentially be included in the left-hand side of the TEAMS architecture diagram shown in Figure 1 (Data Maintenance and Asset Management Applications). The descriptions also include information relevant to undertaking the kind of integration envisioned for TEAMS – both across different asset management applications, and between the asset management applications and the enterprise data repository and applications on the right side of Figure 1.

The section concludes with an assessment of existing and planned applications and existing data in relation to the TEAMS vision.

4.2 Street System Geography and Characteristics

The legacy Street Inventory System (SIS) is the major repository of street system characteristics. It represents an evolutionary effort to bring together basic enterprise information about the street system under a common umbrella. SIS information includes street and block identification, functional and administrative classifications, special routes, block lengths, lane and shoulder widths, pavement layers, median and curb types, traffic volumes, pavement inspection data, and capital projects. The current SIS was written in Clipper (dBase files) for a DOS environment. While DDOT staff still use this system for maintaining much of the basic inventory data, preparing the HPMS submittals, and updating capital project information, it has been a challenge to maintain the system's functionality with the introduction of new computers and operating systems that were not conceived of at the time the SIS and its development tools were created. Nonetheless, even though the SIS is technologically outmoded, it provides an excellent starting point for TEAMS, with respect to the common location reference method, the definition of enterprise attributes, parameter tables providing pick lists of values for attributes, and design of core functionality that makes use of the enterprise information.

This system identifies every street intersection in the District with an ID consisting of a single-digit quadrant code, a four-digit street name code, and a three-digit intersection sequence code (which roughly corresponds to the 100 block number). Data for blocks are represented by the SIS ID for their starting intersection (following a common directional convention). Data specific to a particular side of the road also is identified by a road side code (odd/even). Each side of a divided highway has a distinct code, allowing for separate data for each direction. SIS information also may be identified with a road type code that denotes the type of segment whether the information pertains to an intersection, block, ramp, couplet, frontage road, bikeway, etc. Information pertaining to a specific lane is identified with a sequential lane number (from left to right along the street moving in a direction away from the Capitol). Data that pertains to a portion of a block is assigned a segment ID – which is a sequential number within a block.

The integration of SIS and GIS is a key requirement of the TEAMS project. The SIS is the foundation for DDOT's LRS and is a core component of the geodatabase that will be built as part of the TEAMS GIS implementation. The SIS is a legacy database with no graphics capabilities. Therefore it is critical that SIS be migrated into the GIS environment. The SIS link and intersection files are already being replicated in the GIS and integrated with the street centerlines. The SIS file is more easily maintained in a GIS environment and this function is already performed by the GIS staff. All assets with a SIS ID can now be located on the base map. This function is currently performed by the GIS staff on an ad hoc basis, but when TEAMS is implemented users will be able to display and query their data via the map GUI independently. Some of the legacy applications and proprietary databases

tied to SIS will need modification or replacement to take full advantage of these mapping capabilities.

Upgrading the SIS to a windows platform has been repeatedly cited by stakeholders as an initial top priority for TEAMS. This upgrade will necessarily include a transition to maintaining the street geography within a GIS framework from the current SIS table-based methods. Therefore, an upgrade to the SIS is not a simple matter of porting the existing SIS code to a new platform. The TEAMS effort will suggest a phased approach that ensures implementation of the GIS-centric vision for TEAMS while fast-tracking replacement of critical data updating and reporting capabilities now being provided by the SIS.

4.3 Asset Inventory, Condition and Needs Analysis

Existing and planned systems that maintain asset inventory information (location and characteristics), condition or age information, and (in some cases) provide automated needs analysis to assist with candidate project identification and prioritization are as follows:

- **Pavement –** IPMA is using the PAVER product (provided at low cost by APWA) this year, in parallel with the prior DOS-based Pavement Analysis System (PAS) in-house product. They intend to switch over to PAVER next year and sunset use of PAS. PAS was integrated with the old SIS – all of the pavement inspection data were loaded into SIS, and then an automated routine was run each year to create a pavement analysis file from the SIS data. Work will be required in the future to ensure that the pavement data is synchronized with the new enterprise system definitions of the street system. Further investigation is needed to determine what portion of pavement-related data is to be maintained in PAVER (e.g., pavement layers, pavement type, work history), and which data should be included in a more generic street characteristics module of TEAMS. To the extent that PAVER is used as the system of record for certain attributes, a logical approach to integrating the PAVER database with the data warehouse portion of TEAMS needs to be designed. Approaches to replacement of current capabilities of the SIS for estimating the pavement type based on layer information, and for resetting a pavement's condition to excellent when a pavement project's status is set to completed also need to be investigated.

- **Bridge –** IPMA is using the AASHTOWare Pontis bridge management system for maintaining the bridge inventory, entering inspection data and producing the required National Bridge Inventory (NBI) file for FHWA. They also are exploring expanded use of Pontis for support of the bridge program development process. FHWA is funding the required annual license fee for Pontis. DDOT will likely want to shift the Pontis database from the existing Sybase Adaptive Server Anywhere product to Oracle or SQL Server (support to be provided in CY2004). The Pontis data model documentation is published, and the system is amenable to integration with other

elements of TEAMS. One aspect of Pontis integration to be explored is the possibility of populating some of the Pontis database attributes from other TEAMS data sets. In particular, Pontis includes a roadway table (with entries for roads on and under bridges), including attributes such as functional class, NHS status, etc., that are likely to be stored with TEAMS roadway data.

- **Culverts –** IPMA is currently collecting data on culverts and implementing a public domain culvert management system developed for FHWA, distributed by Iowa State LTAP. Current plans are to locate culverts based on outfall point locations. Relationship of this location method to street segments (SIS ID's) needs to be investigated, as does the integration between the culvert management system and TEAMS.

- **Tunnels –** IPMA is currently a test site for the new FHWA tunnel management system developed by Gannet Flemming. Tunnel location referencing/links to GIS and integration with TEAMS needs investigation.

- **Signals –** TSA maintains a file with the locations of all traffic signals; this information has been made available to GIS. A contractor (M.C. Dean) has been relied upon to TSA also maintains a database with a history of malfunctions and indicates when signals were replaced. Much of this data is used for litigation purposes. TSA also uses a traffic information management system (TIMS) in its transportation command center for traffic controllers and signals.

- **Street Lights –** DDOT does not maintain an electronic inventory of locations of the 67,000 street lights in the District. A 10-year old map from PEPCO is available that shows light (as well as manholes and signal) locations. The PEPCO grid system is used as a location reference method for lights.

- **Signs –** DDOT does not maintain an electronic sign inventory.

- **Trees –** The legacy MISTRE application, developed as an integrated application under the SIS umbrella has been recently replaced by the Cityworks Azteca system. This system is currently in the testing phase. MISTRE will be kept on-line for a few years to provide work history data that may be needed.

- **Alleys –** Inventory and condition information on the 300-400 miles of alleys is currently being collected. A system has not yet been identified for as the permanent home for this data; but presumably this would be included in the SIS upgrade.

- **Curbs/Sidewalks –** The existing SIS stores characteristics of curbs and sidewalks (though sidewalk information was lost and is currently being repopulated).

- **Retaining Walls –** The need for an application to manage inventory and condition information about existing retaining walls, as well as maintain a list of locations where new walls may be required has been identified. This effort has not yet been pursued.

- **Impact Attenuators –** A project was started (but not completed) to create an attenuator inventory and develop a list of additional locations where they are needed. This effort

is of interest to both TSA and IPMA, since TSA's role is to identify the need for the attenuators and IPMA is responsible for construction.

4.4 Short-Term Work Requests, Management and Tracking

A variety of systems are in place for initiating, managing and tracking work requests:

- **Hansen Call Center** – this application is used District-wide to log customer calls; and for tracking of how these calls were resolved. This system also is used to generate several performance measures for DDOT will respect to resolution of complaints.

- **SERVES** – used for correspondence tracking. Some of the correspondence generates work requests; these are entered separately into Hansen, but then need to be closed out in both systems.

- **The Street Light Information Management System (SLIMS)** tracks work activity on street lights. The maintenance contractor (M.C. Dean) maintains a version of this system (McSLIMS), as well as an in-house maintenance tracking system. Obtaining timely information on work status has been an issue, and it has been difficult and time-consuming to keep multiple systems in synch. This is further complicated by the fact that roughly 10 to 20 percent of street light work requests are initiated via the Hansen system or SERVES. Therefore, some work requests must be entered and closed in as many as five systems (Hansen, SERVES, SLIMS, McSLIMS, MC Dean's in-house system). A new version of SLIMS, iSLIMS is under development, which will provide a web front-end that can eliminate the need for McSLIMS and eliminate some of the duplicative data entry

- **A Traffic Signal Maintenance Database (TSMD)** is currently under development (in-house), which will provide maintenance management functions for signals. The signal maintenance contractor (M.C. Dean) maintains their own tracking system.

- **A Traffic Signs Maintenance Database** is currently under development (in-house).

- **The Cityworks Azteca** system is currently being tested, and will serve as the work management system for trees. This replaces the functionality formerly provided by MISTRE. A PDA application also is being implemented in order to provide map-based updating capabilities from the field.

- The **Curbside Master Database (CMD)** is an in-house Visual Basic / MS Access application used to track work activities of the TSA Curbside Management Division. It includes a cross-reference to the Hansen ID. Work orders can be queried by ward.

- **The Tracker** system is used to manage work requests and perform activity tracking for the NHS maintenance contractor (VMS). VMS also uses their own in-house maintenance

management system. A web version of Tracker is currently being tested to facilitate updates by DDOT and VMS staff.

- **Route Smart** is a candidate application to route work orders among field staff; paired with Automated Vehicle Location (AVL) system in vehicles.

- The Snow Management Program, currently maintained by the Department of Public Works, will be managed by DDOT beginning this winter.

4.5 Capital Project Tracking/History

There is no single source of information on capital projects at DDOT. New project candidates are submitted to IPMA, primarily in spreadsheets and text documents. The D.C. Office of Budget and Planning (OBP) maintains an Access database of all D.C. capital projects. The six-year capital program is posted to the internal DDOT web site. Information for Federally funded capital projects and 100 percent locally funded projects is maintained separately.

Financial information pertaining to projects is maintained in the District's accounting system – SOAR. An Executive Information System (EIS) interface to SOAR is available to provide query and reporting capabilities. Users must be knowledgeable about the various project and account codes used in the system in order to make effective use of this capability. A "crosswalk" report is available containing the relevant keys for each project/contract.

DDOT is in the process of implementing the pre-construction components of the Trns*port AASHTOWare product. These include:

- **Trns*port Estimator®** – Assists with the development of construction estimates based on historical bid data, or cost data entered from scratch. Data can be transferred into Trns*port PES®.

- **Trns*port PES®** – Proposals and Estimates System; for preparing construction estimate data in preparation for bidding process.

- **Trns*port LES®** – Letting and Awards System; used to advertising and evaluating bids.

- **Trns*port Expedite®** – allows for transfer of estimate from PES® to an electronic bid file, which can be used by contractors to enter their unit price information and/or the agency to enter prices from paper bids. It also allows the bid data to be loaded into LES®.

- **Trns*port BAMS/DSS®** – A bid analysis and decision support module for review and evaluation of bids. Its capabilities include trend analysis and bid competition analysis.

Implementation of the Trns*port SiteManager module for construction management also has been analyzed, but is not funded at this time. Currently, DDOT uses an in-house system called **Constra** to record daily work and calculate payments. It produces the required FHWA standard report on construction quantities and costs (for entry into FMIS). Construct is a stand-alone system, and is not linked to any other financial or status tracking databases.

An in-house application called ProTrack is used within IPMA to monitor construction project schedules and status. Construction projects are entered into this system at an early stage (when proposed for the capital program). ProTrack was designed for compatibility with the SIS, so all projects are identified with a street, from and to location (and internally with an SIS ID). Project status information is entered into ProTrack by the IPMA ward-based project teams. No financial information (other than the original budget) is tracked in this system. One of the major uses of ProTrack is to record the completion date of construction projects, which is used to determine the start date for the moratoria on street cuts. An effort by OSAT to upgrade ProTrack to include a web interface with an Oracle back-end is currently on hold, with the intent that it be carried forward in the future.

IPMA also continues to track pavement project status within the SIS, using the Maintenance/Rehabilitation Action Status screen of the pavement module.

4.6 External Reporting

Major external reporting requirements related to asset management includes Highway Performance Monitoring System (HPMS) information, Traffic Monitoring information, and financial reporting related to capital projects.

HPMS – The SIS includes a module for producing the HPMS report. It includes a set of tables that relate HPMS sample sections to their constituent SIS blocks, as well as processes for creating HPMS "Universe sections" – which are groups of SIS blocks (not necessarily contiguous) that are homogeneous across characteristics such as functional class and pavement type. SIS HPMS processes perform data translations and aggregations from SIS files to the required HPMS codes. The HPMS module also includes data entry screens where information required by HPMS that is not a part of the SIS can be input (including traffic data for representative legs of intersections). For certain items, the user has the option to override a value that was brought in from another SIS file. Validation routines also are included to check that all SIS sections have been included in the HPMS universe data that no SIS block has been double-counted, and that valid data exists for the sample sections. A delimited file in the format required by the FHWA's HPMS editing program is produced.

VTRIS – DDOT uses FHWA's VTRIS program to report vehicle travel characteristics information from traffic count stations. This function will be provided in the new Traffic Monitoring System (see below).

FMIS – FHWA's fiscal management system is used for submittal of required information on capital projects.

4.7 Traffic and Accident Monitoring

A project is nearing completion to design and prepare functional requirements for a **Traffic Monitoring System (TMS)** for DDOT. This system will provide a central repository and system of record for all traffic count information, and will support a variety of analysis and reporting needs, including preparation of the AADT map. As shown on the TEAMS architecture diagram in Figure 1, a separate TMS server will be required due to the large volume of data to be stored.

TARAS is the Traffic Accident Reporting and Analysis System, used to manually enter paper accident reports obtained from the police, and provide simple reporting functions. Accidents are not currently linked to SIS IDs. The need has been identified to make TARAS more suitable for a multi-user environment, as it is currently housed on multiple desktops. The intention is to upgrade this Access-based application to an SQL Server database, and to eventually web enable it. Electronic transfer of accident information is not possible until the police modernize their accident recording and reporting methods.

TSA also uses a commercial product, **AIMS** to prepare collision diagrams. This product includes a much broader set of modules for accident monitoring and analysis, but these are not being used.

4.8 Other

The Curbside Management Division, which issues residential permit parking regulations uses an in-house Web application to query Residential Parking Permit information from the DMV. The data is extracted from the DMV semi-weekly, and further automation in data sharing is possible through an application like FileNet.

The Hansen Permitting module has recently been implemented by the PSMA subsurface permitting unit. Separate MS Access databases for permit activity tracking are in use by the PSMA surface permitting unit, and by the PSMA Inspections Division.

4.9 Assessment of Existing and Planned Applications in Relation to the TEAMS Vision

A variety of applications are in place which provide functionality to meet the needs of individual business units (e.g., pavement and bridge management systems, SLIMS, Azteca). In addition, a few applications have been designed for broader multi-unit or enterprise-wide use (e.g., SIS, SERVES, Hansen Call Center). Several other applications are either planned or under development to either upgrade existing older systems (e.g., ProTrack), or to provide new functionality (e.g., for traffic monitoring). Applications are of varying vintages, using a variety of database types (Access, Oracle, SQL/Server, Dbase), and software platforms (Delphi, Clipper, Access, Visual Basic, PowerBuilder, Cold Fusion). The SIS is still a DOS application, which is increasingly challenging to keep running in a Windows environment. There are a number of other applications which are of more recent vintage, but were designed to stand-alone, with little ability to be integrated with other systems. Clearly there is much work to be done in conjunction with the TEAMS implementation to update existing systems and ensure that they all can work together to support the identified business needs.

The TEAMS vision includes a suite of applications that both support individual work unit needs and also provide enterprise data to the TEAMS central repository that can be accessed from the TEAMS web portal. This vision has the following implications for these applications:

- **Consistent Geographic Referencing –** All physical assets and events related to those assets must use one of the agreed-upon location referencing methods to be supported by the TEAMS GIS engine. Many systems now use the SIS ID, which will be supported within TEAMS. However, location referencing still needs to be addressed for some existing and planned applications, including those for accident records, permitting, and alleys.

- **Coordination with Geographic Data –** Asset data maintenance transactions with implications for geographic data (e.g., adding a new bridge, changing a road alignment and increasing its length) must be either done in the TEAMS geodatabase or at a minimum coordinated with the geodatabase via strict procedures. This coordination will be a central issue for the SIS replacement. It also needs to be addressed for the other core asset inventory applications.

- **Single System of Record for Every Attribute –** There should only be one place where a given data item is updated in order to avoid inefficiencies and inconsistencies. For example, the functional class of a roadway segment should be maintained with the roadway data and then transferred to other systems that use it (e.g., Pontis, HPMS). An enterprise data dictionary is an important tool for ensuring that this occurs.

- **Consistent Coding, Parameters and Identifiers Across Systems –** All systems should make use of consistent codes and identifiers to facilitate data sharing. There is no

master set of codes currently. However, the SIS parameter file provides a starting point for an enterprise code table.

- **Use of GIS technology where appropriate.** The SIS currently uses tabular geographic data (the AGEO file) for finding records pertaining to a given location. It is very difficult to keep all of the SIS attribute data in synch as changes to the underlying geography are made. The HPMS module of the SIS includes functionality for maintaining definitions of sample sections and homogeneous groups of sections that would be more suitable (and less error prone) as a GIS-based application.

- **Linkages to the TEAMS Repository –** All applications contributing enterprise data will need to be linkable via middleware (or via more direct means such as database triggers) to the TEAMS repository, to provide for either live access or data replication with the appropriate data transformations. Use of middleware is currently being explored with the Hansen system. The degree to which other applications are easily linked requires further investigation.

- **Use of Web Technology to Facilitate Update Processes –** Instances (such as SLIMS and ProTrack) where several different applications are used to maintain the same data or where multiple copies of the same data are maintained should be eliminated through development of web-based interfaces which allow for easy updating of the data from multiple locations. There are plans to implement web-based versions of SLIMS and ProTrack.

- **Consolidation or Linkages Across Applications with Similar Functionality –** Applications supporting work tracking functions should either be consolidated, or should be linkable via middleware. This will allow for continuity of work flow across systems, as well as horizontal views across units of planned, scheduled and accomplished work is possible.

Table 3. Listing of Existing Systems

System	Who Maintains System	Business Area Processes	Users	Type of Application	Future Plan	Vendor/ Developer	Database	Application Language	Operating System	Web-enabled?	Location Referencing	Comments
AIMS (Accident Information Management System)	TSA	Collision diagram mapping	TSA- Traffic Safety	Commercial	Unknown	JMW Engineering Inc.	Access (but can work with Oracle and SQL Server)	Unknown	NT/2000	No	Probably can tie to SIS ID	• GIS-based system • Linked to ArcView 3 • Plotting is done by clicking intersections on a map or referring to street names • Querying capability • Lists all accident records for the intersection and produces summaries of collision types, causes, number of injuries, and fatalities
CMD (Curbside Master Database)	TSA	Traffic Operations Activity Tracking	TSA- Curbside Management	In-house	Keep	N/A	Access	Visual Basic	Windows	No	Street location	• Used for tracking activities • Contains own id – for work order, Hansen id #, date submitted, location, due date • Info can be queried by ward
Constra	IPMA	Construction Project Management	IPMA- Design & Construction, Contracting, TSA- Street Lights, IPMA- Project Tracking/ Contract Mgmt	In-house	Replace	N/A	Access	Delphi 6	Windows 95/98	No	No	• Most contracting work is done in this system (small portion of work is done in PASS) • Tied to SOAR, work vouchers • Administered by IPMA, who enters winning construction bid into system • Field inspectors report daily on installed quantities • Payment of contractors tabulated on daily basis • Produces FHWA-formatted report on cost per pay item and quantities • Stand-alone system that generates Excel files; output files are not saved • Would be helpful if tied to ProTrack • System due for replacement • Proposed “Site Manager” application by Info Tech was intended to be a replacement, but not currently funded
DPW SERVES (Serves)	DPW	Correspondence Tracking	All Divisions	Commercial	Unknown	Cyclone Publishing	SQL Server	Visual Basic	Windows	Unknown	Street address, block #, nearest intersection, quadrant, neighborhood, ward	• Problems include lack of connectivity between Serves and Hansen (each functions independently of one another) • Problems with tickets not being closed out properly • Tracks work orders and creates reports by date, location, requestor of service, referred agency, service type, completion status, employee, total work orders • Reports service delivery performance of different administrations; work “overdue,” work “not late,” work “on time” • Current effort to link related work orders to track process flow • May be candidate for File Net

Table 3. Listing of Existing Systems (continued)

System	Who Maintains System	Business Area Processes	Users	Type of Application	Future Plan	Vendor/ Developer	Database	Application Language	Operating System	Web-enabled?	Location Referencing	Comments
FMIS (Fiscal Management Information System)	U.S. DOT-Federal Highway Administration	Federal Obligation Tracking/ Reporting	CFO, CFO-Capital Budgeting	External system	Keep	Unknown	Unknown	Unknown	Unknown	No	Unknown	• FHWA/DDOT financial tracking system for Federal-aid highway projects • Each project has unique Federal ID number
Hansen- Call Center	District of Columbia Government-Office of the Mayor	Customer Management, Performance Reporting	All Divisions	Commercial	Keep	Hansen Information Technologies	SQL Server	Unknown	NT/2000	Yes	Street address, intersection, block	• Closed architecture; does not interface with SIS • Subset of Hansen, called IQ, stores special Hansen requests • Contains service #, list of standard problem codes, call date, source, priority, responsible agency, requestor information, etc. • Cannot assign IPMA responsibility codes because focus is on resolving short-term work orders • No connectivity to DPW SERVES • Provides monthly performance tracking, which is linked to performance goals
McSLIMS	M.C. Dean	M.C. Dean Signal Management	M.C. Dean, TSA- Street Lights	External system	Unknown	M.C. Dean	Unknown	Unknown	NT/2000	No	Street address	• Contractor's own version of SLIMS
MicroStation	IPMA	CAD/ Drawing	IPMA- Design & Construction	Commercial	Keep	Bentley	Access, Oracle, SQL Server	MDL	Windows	Yes	Unknown	• Can be web-enabled • Can have location referencing
MISTRE (Management Information System for Street Trees)	Urban Forestry	Tree Maintenance Management	Urban Forestry	In-house	Replace	N/A	Access 97	Visual Basic	Windows NT/2000	No	SIS ID and additional 6 digits for exact linear footage of where that street is (additional digits are unique to Urban Forestry)	• Contains historical data • Will be retained for about 3 years, then phased out and archived • To be superseded by Cityworks • Currently effort underway to match MISTRE unique ID #s and location ID #s in the GIS layer; matched ID – will be loaded into Cityworks, which will reference both numbers
NCD (Neighborhood Cluster Database)	District of Columbia Government-Office of the Mayor	Ward Planning	TPPA-Planning, Customer Service, Customer Service	External system	Keep	Unknown	Access	Visual Basic	Unknown	Unknown	None	• Maintained in Mayor's Office of Neighborhood Services • Inputs consist of neighborhood activity and community information
Pavement Field Data Collection	IPMA	Pavement Management	IPMA	In-house	Replace	Cambridge Systematics	Clipper	Clipper	DOS	No	SIS ID	• Prepared empty file of inspections for field computer based on user-selected set of streets • Handles uploads of the data back into the SIS pavement condition data files

Table 3. Listing of Existing Systems (continued)

System	Who Maintains System	Business Area Processes	Users	Type of Application	Future Plan	Vendor/ Developer	Database	Application Language	Operating System	Web-enabled?	Location Referencing	Comments
PAS (Pavement Analysis System)	IPMA	Pavement Management Capital Program Development	IPMA	In-house	Replace	Cambridge Systematics	Clipper	Clipper	DOS	No	SIS ID	
Pontis- Bridge Management	IPMA	Bridge Management	IPMA- Design & Construction, IPMA- Pavement and Structure Management	Commercial	Keep	AASHTOWare	Oracle, Sybase ASA. SQL Server in ver. 4.4 (CY04)	PowerBuilder and C++	Windows	No	Latitude/longitude; HPMS-compatible linear referencing info (inventory route + km post)	• Stores all NBI data and produces NBI file • Stores additional element-level condition data • Used for data storage/reporting; can be used for program development purposes • FHWA funds annual license fee for DDOT
ProTrack (Project Life-Cycle Tracking)	IPMA	Capital Project Management, Project Tracking/ Monitoring	IPMA- Design & Construction, IPMA- Pavement and Structure Management	In-house	Replace	N/A	Access	Delphi 6	Windows 2000	No	SIS ID, links and intersection	• Creates index of projects • Pulls information from the PMS • Has scheduling and budgeting information, including start date of five-year moratoria on street cuts • Only tracks project status, not actual costs • Used as high-level planning tool • Being re-written in Cold Fusion with Oracle database • Not tied to construction management vouchers
SIS – Resident Permit Parking	TSA	Parking Operations	TSA- Curbside Management	In-house	Unknown	N/A	Clipper	Clipper	DOS	No	SIS ID	
SIS – HPMS	IPMA	Federal HPMS Reporting	IPMA	In-house	Replace	Cambridge Systematics	Clipper	Clipper	DOS	No	SIS ID, HPMS ID	• Subsystem in SIS • Extracts data to produce required HPMS submittal file • Includes many validation routines to check SIS data
SIS – Street Inventory System	OSAT- Spatial Data Systems	Multiple	IPMA	In-house	Replace	N/A	Clipper	Clipper	DOS	No	SIS ID	• Currently running in DOS window
SIS - Transportation Improvement Program (TIPS)	IPMA	Planning	IPMA- Pavement and Structure Management, TPPA Capital Budgeting/ Internal Performance Reporting	In-house	Replace		Clipper	Clipper	DOS	No	SIS ID	• Currently linked with SIS pavement information to update pavement condition automatically upon project completion
SLIMS (Street Light Information System)	TSA	Street Light Maintenance Management	TSA- Street Lights	In-house	Upgrade	Cyclone Publishing	Access 97	Unknown	NT/2000	No	Street Address	• Work-order type system • In transition to web-based (iSLIMS) • Will be upgrading to SQL Server

Table 3. Listing of Existing Systems (continued)

System	Who Maintains System	Business Area Processes	Users	Type of Application	Future Plan	Vendor/ Developer	Database	Application Language	Operating System	Web-enabled?	Location Referencing	Comments
SOAR (System of Accounting and Reporting)	CFO	Finance	CF0- Budgeting, Contracting, TPPA- Capital Budgeting/ Internal Performance Reporting	Commercial	Keep	Unknown	Unknown	Unknown	Unknown	No	Unknown	• Tracks pre-encumbrances, obligations, financial info on any project by phase • Includes broad categories of assets: roads, bridges, land, buildings • EIS module is web-based; can query expenditures by project and information on operating budget in real-time • Will have linkage to PASS procurement system • Will have interface with small purchase system, which will do acquisitions online and ascertain budget availability • Capital Budgeting enters funding info manually into SOAR
TARAS (Traffic Accident Reporting System)	TSA	Accident Monitoring, Federal Safety Reporting	TSA- Traffic Safety, TPPA- Capital Budgeting/ Performance Reporting	In-house	Upgrade	N/A	Access 97/ Clipper	Visual Basic	Unknown	No	Street intersections	• Will be upgraded to Oracle • Used for manual data entry of accident reports • Can be linked to GIS using SIS ID (not currently done)
Tracker	IPMA	IPMA- NHS/ VMS Contract Mgmt	IPMA- NHS/ VMS Contract Mgmt	In-house	Keep	N/A	Access 97	Unknown	Unknown	No	Block, street name, nearest intersection	• Internal system to manage VMS work • Related to Tracker/VMS, which is a web-enabled version
Tracker/VMS	VMS	Project Tracking	VMS, IPMA- NHS/VMS Contract Mgmt	External system	Keep	VMS	Unknown	Unknown	Unknown	Yes	Route, beginning street, ending street, direction, block, street name, nearest intersection	• Creates VMS Weekly Management Report of lighting accomplishments, small sign plan & accomplishments, future work, pending issues, ongoing issues, current work planned, paving plan
Utility Works Notification Systems	PSMA	Construction and Utilities Coordination	PSMA	In-house	Keep	Unknown	Access 2000	Delphi 6	Windows 2000	No	SIS ID	• As utilities submit two-year plans, a SIS ID gets added • Then utilities (using the SIS ID) and DDOT divisions can use web-enabled ArcIMS to locate projects where construction is about to take place and utilities have been notified
VTRIS (Vehicle Travel Information System)	U.S. DOT- Federal Highway Administration	Federal Traffic Reporting	TSA- Traffic Safety	External system	Unknown	Signal Corp. and FHWA Office of Highway Policy Information	Unknown	Unknown	Unknown	No	Unknown	• Application validates, facilitates editing, summarizes and generates reports on vehicle travel characteristics • Maintains permanent database of station description, vehicle classification, and truck weight measures in metric units • Has MS Graph software

Table 4. Listing of Planned Systems

System	Business Area Processes	Users	Type of Application	Future Plan	Vendor/ Developer	Database	Application Language	Operating System	Web-enabled?	Location Referencing	Comments
iSLIMS	Street Light Maintenance Management	TSA- Street Lights	In-house	Keep	N/A	SQL Server 7.5	Unknown	Windows NT/2000	Yes	Street address	• For the 80% or requests that go to straight to M.C. Dean (contractor) • Enables M.C. Dean to key requests over the web and DDOT can get them electronically
PASS	Small Procurement Management	CFO- Budgeting, Contracting	Commercial	Upgrade	Ariba	Unknown	Unknown	Unknown	Unknown	Unknown	• Automated procurement system • Capability to handle change orders • Will link to SOAR
Route Smart	Snow Vehicle Routing	PSMA- Street & Bridge Maintenance	Commercial	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Should be SIS	• GIS-based package • Requires a navigable database that OCTO is developing • Will be used in conjunction with an AVL system
TMS/H (Traffic Monitoring System for Highways)	Traffic Monitoring & Reporting	TSA- Traffic Safety	In-house	Keep	Unknown	N/A	Unknown	N/A	Unknown	Unknown	• Functional requirements under development
TSMD (Traffic Signal Maintenance Database)	Traffic Signal Maintenance Management	TSA- Signals	In-house	Unknown	N/A	SQL Server	Unknown	Unknown	Yes	Unknown	• Database will contain history of malfunctions and indications of when equipment was replaced • Under development; web front-end; SQL back end • Open standards • Will likely interface with SeeBeyond

Table 5. Listing of Systems in Testing Mode

System	Business Area Processes	Users	Type of Application	Future Plan	Vendor/ Developer	Database	Application Language	Operating System	Web-enabled?	Location Referencing	Comments
Cityworks-Azteca	Tree Maintenance Management, Performance Reporting	Urban Forestry, TPPA- Capital Budgeting/ Internal Performance Reporting	Commercial	Keep	Cityworks	Oracle	Unknown	Windows NT/2000	Unknown	SIS ID and additional 6 digits for exact linear footage of where that street is (additional digits are unique to Urban Forestry)	• Designed to supersede MISTRE • Along with GIS, takes data from Hansen and geocodes the information and creates a service request • Opportunities in functionality include real-time info sharing, seamless communication with Hansen (closing out service request), and storm damage reporting • System includes Arc Pad: • A hand-held device • Contains text (standard request form) and graphics • Uses cradle for downloads; real-time synchronization occurs back on the server • Field staff can download map of specific ward; through GIS, can geocode, plot, and reconfigure tree location in the field if actual location differs from reported location
FileNet	Work Flow, Document Management	All divisions can be potential users	Commercial	Keep	FileNet	Oracle	Unknown	Windows NT/2000	Yes	Capability for spatial referencing to SIS ID	• Performs versioning, publishing; transforms docs into Adobe Acrobat files • Can archive in wide-angle format for legal purposes • Will track the development of a document • Can automate process flow • Allows for content-based searching • Supports spatial indexing of documents • Possible to link to Hansen with SeeBeyond middleware • Can link to GIS so user can click map location and obtain list of documents tied to that location
Hansen-Permitting	Permit Tracking	PMSA-Permitting	Commercial	Keep	Hansen	SQL Server	Unknown	Windows NT/2000	Unknown	Street address, intersection, block	• Closed architecture, but attempts underway to have open API • Does not interact with Call Center Application • Separate from permitting system used by DCRA, which is a FileNet application
PAVER (Pavement Management System)	Pavement Management	IPMA- Design & Construction, IPMA- Pavement and Structure Management, TPPA- Capital Budgeting/ Internal Performance Reporting	Commercial	Keep	APWA	Unknown	Visual Basic	Windows	No		• Stores pavement inspection data • Predicts future condition • Pavement Program Development Functions • Replaces Pavement Analysis System (PAS) – legacy PMS integrated with SIS • Being run in parallel with PAS for a year • Includes GIS capability
White Ticket	Work Permit Validation and Enforcement	PSMA-Investigations	In-house	Unknown	N/A	SQL Server	Cold Fusion	Windows 2000	Yes	Unknown	• Verify status – may be upgrade to existing system

5.0 Off-the-Shelf Systems Review

This section describes the systems that are considered viable candidates for providing some of the existing and planned capabilities for TEAMS.

5.1 Overview of Commercial Off-the-Shelf Systems

An important resource for this report was the experience and information accumulated by Cambridge Systematics in the course of work on the National Cooperative Highway Research Program (NCHRP) Project 20-24(11) "Asset Management Guidance for Transportation Agencies" and NCHRP Project 20-57 "Analytical Tools to Support Asset Management."[1] Additional candidate systems were identified based on an extensive web search, supplemented with recommendations from other state DOTs. Initially, 25 systems were identified as likely candidates. Systems that did not have a proven track record at the state or local level in the United States that appeared to be custom developments rather than commercial off-the-shelf (COTS) packages, or were considered to have a focus on capabilities that would duplicate existing systems (or those under development) that DDOT expects to keep (e.g., pavement management systems) were then excluded from the list. The vendors of the remaining 18 systems were contacted for additional system details.

A majority of the systems listed below include some degree of asset management, work management, maintenance management, and service request management capabilities. In addition, many of them include in-built GIS module and/or are compatible with ESRI products such as ArcView 3.x, ArcGIS, and ArcIMS. A few of the systems also are compatible with the ESRI Geodatabase. Nearly all of the systems allow the user to add fields, forms, and queries; a few systems include a dedicated module that supports such customization. While a few of the larger companies – particularly companies with an emphasis on products rather than services – have ISO 9001 and/or CMM certification or are actively pursuing certification, most of the smaller companies have not gone through a formal certification process.

An attempt was made to identify at least two viable alternatives for each DDOT system. The only exception is the traffic monitoring system, for which only one suitable candidate could be found. In many cases there are several COTS products to chose from. The systems selected are proven systems with implementations elsewhere. An analysis was conducted to evaluate the capabilities of the COTS with the application functionalities

[1] Ref. NCHRP Project 20-57 "Analytical Tools to Support Asset Management."

described in Section 4.0. A brief description of each system can be found below and Table 6 (at the end of this section) summarizes their main characteristics. As well as meeting the business functions, Table 6 indicates each systems' compatibility with the TEAMS system architecture based on six criteria (GIS module, web accessible, database management system, GIS platform, software platform and operating system). Each system is ranked from 1 (low) to 6 (high) compatibility with the TEAMS system.

Deighton Total Infrastructure Management System (dTIMS) – The Deighton Total Infrastructure Management System (dTIMS CT) is an asset management system developed by Deighton Associates, Ltd. The system is capable of managing pavements, bridges, railways, signs, sewer systems, water systems, or any other asset. The software is designed to be extremely flexible and to allow the user to define and manage any asset type. In addition, the OLE DB module facilitates the creation of custom reports, forms, and queries.

CartêGraph's Management Software Suite – CartêGraph Systems, Inc. has developed a variety of asset management software with asset management, work management, permit management, and service request management functionality. The software is capable of managing a variety of infrastructure assets, including pavements, bridges, vehicles, signs, signals, and other roadside features. CartêGraph's *flex*Technology allows the user to add custom fields, forms, queries, and scripts to the software. In addition, CartêGraph's VERSA*Tools* module allows the user to create customized management software.

Infrastructure2000 – Infrastructure2000 is a management software developed by Vanasse Hangen Brustlin (VHB), Inc. with asset management, work management, and permit management functionality. The software is capable of managing a variety of roadway features and roadside features, including pavements, sidewalks, signs, utility features, and lighting. In addition, VHB is planning to move the software into Microsoft's.NET environment and anticipate that this will ease integration with other management systems.

Highways – EXOR Corporation's Highways is a comprehensive infrastructure management software that incorporates planning and budgeting, asset management, maintenance management, work management, service request management, project management, accident reporting, and (through TRADAS) traffic monitoring functionality. In particular, Highways has very strong capabilities for spatial data management and has been integrated with the ESRI geodatabase. Kansas DOT and Indiana DOT have used middleware to integrate EXOR with their management systems.

MaintStar Municipalities Suite – The MaintStar Municipalities Suite is a comprehensive maintenance management software developed by Bender Engineering, Inc. The software includes functionality for asset management, work planning and budgeting, capital program management, permit and contract management, and regulatory compliance management.

GBA Master Series – The GBA Master Series is a maintenance management system developed by GBA Master Series, Inc. The software includes functionality for asset management, complaint tracking, work management, and accident reporting. The software includes a Geodatabase that is essentially an extended version of the ESRI geodatabase, and also can work with other Geodatabase models. The software is compatible

with ArcView 3.x, ArcView 8.x, and all ArcGIS products. GBA has worked very closely with ESRI in the past, and were an ESRI strategic partner until last year.

Agile Maintenance Manager – The Agile Maintenance Manager is a maintenance management system developed by Texas Research and Development, Incorporated (TRDI). The software incorporates maintenance planning, labor/equipment/materials management, service request management, and work order management capabilities. The system includes a Reports Module that can be used to create custom queries, forms, reports, graphs, and GIS reports. In addition, the latest version of the software includes a GIS module developed using ESRI MapObjects. TRDI has integrated the system with the MARS financial management system in Kentucky, and with SAP in North Carolina.

Kiva Development Management System (DMS) – Kiva DMS includes functionality for asset management, work management, permit and inspection management, license management, land information management, and service request management. The system is capable of managing pavement, roadway, signs, facilities, water systems, lighting systems, vehicles, any other assets. Kiva – the developer of the software – has since been acquired by Accela, Inc. and it is unclear if they are developing the software any further.

Hansen Infrastructure Management Solutions – Hansen Information Technologies offers a comprehensive suite of infrastructure management software, with functionality for budgeting and planning, work management, service request management, asset management, transportation permit management, license management, code enforcement, and accident reporting. Hansen's GIS modules are ArcGIS extensions that can use any data format supported by ArcGIS, including shape files, SDE layers, or a Geodatabase. The Hansen system supports multiple linear referencing systems, and includes several tools for managing and working with linear data. Hansen has interfaced their product with other management systems in several instances.

Cityworks – Cityworks is a GIS-based system that incorporates asset management, work management, and service request management capabilities Cityworks is fully integrated with ArcView version 3.x and 8.x as well as ESRI's ArcGIS platform, and utilizes the ESRI Geodatabase for data management. The software is capable of managing a variety of assets, including streets, structures, intersections, railroad crossings, street lights, signs, signal heads, detectors, curbs, and water systems. Cityworks incorporates open database architecture and includes a published Geodatabase schema.

Trns*port – Trns*port is a comprehensive work management system developed by Info Tech, Inc. and marketed to state transportation agencies through AASHTO. The software incorporates bid management, pre-letting management, cost estimation, letting and awards management, and construction management capabilities. The software has been implemented at several state DOTs and other transportation agencies. The software can be customized at the GUI, report, database, or business logic level as part of the implementation process.

Program/Project Management System (PPMS) – PPMS is a management system developed by Xybernaut Solutions, Inc. to support capital improvement programs of state DOTs. The software incorporates program management, project management, resource

management, and task management capabilities. In addition, DOT's have integrated PPMS with their GIS, financial management systems, and AASHTOWare products.

Maximo – Maximo is a management system developed by MRO Software, Inc. that incorporates asset management, work management, materials management, and purchasing capabilities. Although the software is not specifically targeted for infrastructure asset management, it has been adopted by several transportation and public works agencies, including Delaware DOT, Maryland DOT, and Long Island Rail Road. The software utilizes a J2EE component-based architecture and XML standards that facilitate integration with other management systems.

Traffic Data System (TRADAS) – TRADAS is a traffic monitoring system developed by Chaparral Systems Corporation that complies with the standards outlined in FHWA's *Traffic Monitoring Guide* and AASHTO's *Guidelines for Traffic Data Programs.* TRADAS incorporates a variety of traffic data analysis and reporting capabilities, including site management, quality control, AADT estimation, factor calculation, and traffic data management. TRADAS is designed to work with traffic volume, speed, vehicle classification, and axle load data from permanent sites, portable count stations, and traffic management centers. In addition, EXOR markets TRADAS together with the Highways system. A number of agencies have integrated TRADAS with other management systems (primarily the agency's GIS) using middleware.

SAP Software Suite – SAP has developed a wide range of software products for public sector clients that incorporate asset management, materials and fleet management, budgeting and planning, program and project management, contract management, procurement process management, and customer relationship management capabilities. Although SAP's clientele include several state governments, it is unclear whether the software has been adapted for state DOTs.

Transportation Asset Management System (TAMS) – TAM is a management system developed by 3M that incorporates asset management and service request management capabilities. The software is capable of managing a variety of road assets, including signals, signs, street lighting, parking meters, guard rails, crosswalks, pavement markings, sidewalks, curbs, sewers, and hydrants.

Vehicle Travel Information System (VTRIS) – VTRIS is a traffic monitoring system developed by Signal Corporation for the FHWA Office of Highway Policy Information. The software is distributed among all state agencies and FHWA field offices. The system supports vehicle travel characteristic analysis and reporting.

5.2 Evaluation of COTS Systems for TEAMS

In addition to the general assessment of COTS compatibility with the TEAMS architecture, an evaluation was undertaken to determine which of the candidate systems match DDOT specific requirements in 14 business areas. The information was collected from the vendors in an e-mail and telephone survey conducted as part of the Task 1 review. Table 7 summarizes the results. As mentioned earlier, except for traffic monitoring, there are choices in each area. The systems are categorized into two tiers related to their capabilities to meet the program area requirements without creating any new fields (1) or they can meet the requirements if some custom fields are created (2). While Tier 1 applications are generally more cost-effective this is not always the case and this table should be used as a general guide only. Generally there are several available products for each business area which indicates a competitive market. The most compatible COTS products appear to be those with a high ranking that require only a minimum of customization or configuration.

DDOT has expressed a preference to use COTS products where these meet the department's business needs. TEAMS introduces additional criteria related to the openness of COTS products (e.g., published API) and compatibility with the GIS subsystem. Tables 6 and 7 indicate those products which appear to be most compatible with the TEAMS vision. Products with a low score may still be feasible if they can overcome their limitations with respect to the TEAMS architecture. As described in Section 2.0, the COTS products comprise one subsystem. The other subsystem is the enterprise GIS data repository and enterprise level applications, such as the linear referencing system. The GIS and enterprise level applications will need to be built through custom development, using ESRI's geodatabase model and customizing the GIS software. None of the COTS products offer a complete enterprise GIS solution, although many of them are compatible with GIS software. Thus, the COTS systems are best applied to the specific business areas, whereas the TEAMS GIS will be a custom development. The success of TEAMS will be dependent upon the extent to which the two subsystems can be integrated to provide an enterprise asset management system.

Table 6. TEAMS Candidates

				TEAMS COMPATIBILITY CRITERIA									
System	**Developer**	**Capabilities**	**Assets**	**Built-in GIS Module**	**Web-Based**	**Database System**	**GIS Software**	**Software Platform**	**Operating System**	**TEAMS Score (6 max)**	**Users**	**Web Site**	**Contact**
Deighton Total Infrastructure Management System (dTIMS CT)	Deighton Associates, Ltd.	Asset management	Pavement, bridges, railways, signs, sewer system, water system, any other asset	In development	No	Access 2000; Can use any ODBC-compliant system	NA	Visual C++	Any Windows system above Windows 95	3	Denver, Colorado; South Dakota DOT; Vermont DOT; Oklahoma DOT; Colorado DOT; Utah DOT; Connecticut DOT; Louisiana DOT; Iowa DOT	http://www.deighton.com/ct_overview.htm	Deighton Associates Ltd. 112 King Street East Bowmanville, Ontario L1C 1N5, Canada; Phone: (905) 697-2644; Fax: (905) 697-2645; E-mail: info@deighton.com
CartêGraph Asset Management Software Suite	CartêGraph Systems, Inc.	Asset management, work management, customer service management, permit management	Pavement, bridges, signs, signals, lighting, pavement markings, sewer system, water system, storm water system, vehicles, sidewalks, guardrails, parks, trees, roadside management	Yes	No	Oracle 8i/9i, S Access 2000, MS SQL Server 7/2000	ArcView 3.x, ArcGIS 8.x	Visual Basic, C++, XML, HTML	Windows 95/98/NT/ME/2000/XP	5	Salt Lake City, Utah; Manhattan, Kansas; Springfield, Missouri; Casper, Wyoming; Sioux City, Iowa; Orem, Utah; Yuba City, California; Dubuque County, Iowa; Sullivan County, New York; Clark County, Nevada; Texas	http://www.cartegraph.com/software.html	Cartegraph Systems Inc. 3600 Digital Drive Dubuque, IA 52003; Phone: (563) 556-8120; Fax: (563) 556-8149;
Infrastructure2000	Vanasse Hangen Brustlin (VHB), Inc.	Asset management, work management, permit management	Pavement, roadway, sidewalks/bikeways, pedestrian ramps, trees, drainage features, utility features, street lighting, guard rails, signals, signs, pavement markings	Yes	NA	MS SQL Server 7/2000	ArcView 3.x, ArcView 8.x, Arc IMS	Borland Delphi 5	Windows 95/NT/2000/XP	3	Ulster County, New York; Waterford, Connecticut; Prairie Village, Kansas	http://www.vhb.com/software.html	Vanasse Hangen Brustlin, Inc. 101 Walnut Street P.O. Box 9151 Watertown, MA 02471; Phone: (617) 924-1770; Fax: (617) 924-2286; E-mail: software@vhb.com
Highways by EXOR	EXOR Corporation	Asset management, planning, work order management, maintenance scheduling, accident management, traffic management (through TRADAS), projects management, street works management	Pavement, bridges, culverts, traffic signals, signs, guardrails, street markings, street lighting	Yes	No	Oracle 9i/8i	ArcView 3.x, ArcGIS, Arc IMS	Oracle Developer, Java, Html, Visual Basic, C++		5	Virginia DOT; Kansas DOT; Kentucky Transportation Cabinet; Indiana DOT; British Columbia, Canada	http://www.exor.co.uk/products_top.cfm	11130 Main Street Plaza 3, Suite 206 Fairfax, VA 22030; Phone: (703) 279-3600; Fax: (703) 591-2257
MaintStar Municipalities Suite	Bender Engineering, Inc.	Work planning, budgeting, capital project management, regulatory compliance management, contract and permit management, asset management, energy tracking, invoicing	Pavement, roadway, sewers, signs, facilities, equipment, material	No	Yes	Oracle 8i/91, MS SQL Server 7/2000/2003, Sybase 7	ArcView 3.x, ArcView 8.x, ArcInfo	Sybase Power-builder	Windows 95/98/2000/ME/NT	4	City Of El Paso, Texas; City of Santa Clarita, California; City of Augusta, Georgia	http://www.maintstar.com/Products/Municipalities/municipalities.html	Bender Engineering 28 Hammond, Unit D Irvine, CA 92618; Phone: (800) 255-5675; Fax: (949) 458-7626; E-mail: info@maintstar.com

Table 6. TEAMS Candidates (continued)

System	Developer	Capabilities	Assets	Built-in GIS Module	Web-Based	Database System	GIS Software	Software Platform	Operating System	TEAMS Score (6 max)	Users	Web Site	Contact
GBA Master Series	GBA Master Series, Inc.	Complaint tracking, work order generation, work order scheduling, asset management, accident reporting	Pavement, roadway, signs, storm water system, sewer system, water system, equipment	Yes	No	Oracle 8.i, Microsoft SQL Server 7.0 and 2000, Microsoft Access	ArcView 3.x, ArcView 8.x, other ArcGIS products	Microsoft Visual C++	Windows 95b/98/ME/XP/NT 4.0 (service pack 5 or later), Windows 2000	5	Concord, CA; Greeley, CO; Hampton, NH; Longview, WA; Oak Harbor, WA; Exeter, NH; Manchester, CT; Washington Suburban Sanitary Commission, MD; ADS Environmental Services, Inc; Wayne, NJ; Plainfield Area Regional Sewer Authority, NJ; CME Associates, Inc.	http://www.gbamasterseries.com/Software.html	GBA Master Series 8900 Ward Parkway, Suite 100 Kansas City, MO 64114; Phone: (816) 363-2900; Toll free: (800) 492-2468; Fax: (816) 363-8444; E-mail: info@gbamasterseries.com
TRDI Asset Management Software Suite	Texas Research and Development Incorporated (TRDI)	Asset management, work management	Pavement, bridges, other roadway assets	Yes	Yes	Oracle 8i (have tested with MS SQL Server 7 as well)	ArcView 3.x, ArcGIS	Sybase Power-builder, C++, Java	Windows 98/2000/NT/XP	5	Chicago, Illinois; Delaware; Kentucky; Montana; New Mexico; North Carolina; Oregon; Pennsylvania; Quebec	http://www.trdi.com/content/trdi_maintenance.html	TRDI 2602 Dellana Lane Austin, TX 78746; Phone: (512) 327-4200; Fax: (512)328-7246; E-mail: Info@trdi.com
KIVA Development Management Software (Kiva DMS)	Accela (acquired Kiva)	Asset management, work management, permit and inspection management, license management, land information management, customer service management	Pavement, roadway, signs, facilities, water systems, lighting systems, vehicles, any other asset	Yes	Yes	Oracle	ESRI Map-objects	Visual Basic		6	Atlanta, GA; Charlotte, NC; Henderson, NV; Minneapolis, MN; Kansas City, MO; Los Alamos, NM; Phoenix, AZ; San Diego County, CA; Topeka, KS	http://www.accela.com/usa/corporate/solutions/kiva_dms.htm	Accela 4160 Dublin Boulevard, Suite 128 Dublin, CA 94568; Phone: (925) 560-6577; Fax: (925) 560-6570; E-mail: info@accela.com
Hansen	Hansen Information Technologies	Budgeting and planning, work management, call center/customer service management, asset management, accident reporting, transportation permit management, code enforcement	Pavement, roadway, streets, bridges, intersections, appurtenances, trees, sewer system, water system, storm water system, fleet, parks	Yes	Yes	Oracle 8i/9i, MS SQL Server 7/2000, MS Access 97/2000.	ArcView 3.x, ArcView 8.x, other ArcGIS products	Visual C++	Windows 98/2000/NT/XP	6	Caltrans; Buffalo, NY; Columbia, MO; New York, NY; Las Vegas, NV; Portland, OR, Tulsa, OK	http://www.hansen.com/doc.asp?ID=4	Hansen Information Technologies 1745 Markston Road Sacramento, CA 95825; Phone: (916) 921-0883; Toll free: (800) 821-9316; Fax: (916) 921-6620; E-mail: information@hansen.com
Cityworks	Azteca Systems	Asset management, work management, customer service management	Streets, bridges, intersections, railroad crossing, traffic signals, striping, guardrail, street lights, signs, signal head, detector, curb, gutter, median, street furniture, water system, waste water system, storm water system, parks, trees	Yes	No	Oracle, Sybase, MS SQL Server, Informix, MS Access	ArcView 3.x, ArcGIS 8.x, ArcIMS	Map-objects, Visual Basic	Windows 98/2000/NT/XP	5	Houston, TX; Salt Lake City, UT; Edmond, OK	http://www.azteca.com/products.htm	Azteca Systems 11075 State St., #24 Sandy, UT 84070; Phone: (801) 523-2751; Fax: (801) 523-3734; E-mail: info@azteca.com

Table 6. TEAMS Candidates (continued)

System	Developer	Capabilities	Assets	Built-in GIS Module	Web-Based	Database System	GIS Software	Software Platform	Operating System	TEAMS Score (6 Max)	Users	Web Site	Contact
Trns*port	Info Tech, Inc.	Bid management, preletting management, cost estimation, letting and awards management, construction management	NA	NA	No	Oracle 8i, Sybase, DB2 5	NA	Sybase Power-builder, C++	Windows 98/2000/NT/XP (for the client)	2	AASHTO (Vendor)	http://www.aashtoware.org/aashtoware/products/trnsport.nsf/allpages/overview?opendocument	Info Tech, Inc. 5700 S.W. 34 Street, Suite 1235 Gainesville, FL 32608; Phone: (352) 381-4400; Fax: (352) 381-4444; E-mail: tom.rothrock@infotechfl.com
Program/Project Management Systems (PPMS)	Xybernaut Solutions, Inc.	Work management, project management	NA	NA	NA	Oracle, MS Access, MS SQL Server, DB2				1	Minnesota DOT; Louisiana DOT; Montana DOT; New York DOT; Maine DOT; Tennessee DOT	http://www.xybernaut solutions.com/Products_and_Services/Proj_Mgmt/proj_mgmt_PPMS.htm	Phone: (703) 631-6925; E-mail: xsi_info@xybernaut.com
Geoplan	Regional Planning Technologies	Asset management, permit management, code enforcement, zoning and appeals management, service management	Pavement, roadway, signs, sanitary system	Yes	No	NA	ESRI Map-objects		NA	3	Number of cities and townships in PA; Aurora, OH; Ferguson, MO; Fort Mitchell, KY	http://www.rpt.com/	Regional Planning Technologies, Inc. 800 Vinial Street, Suite B307 Pittsburgh, PA 15212; Phone: (412) 322-7720; Fax: (412) 322-7804; E-mail: geoplan@rpt.com
Maximo	MRO Software	Asset management, work management, project management			Yes	Oracle 8i/9i and MS SQL Server 7.x/2000		J2EE	IBM WebSphere or BEA Logic (for application server)	3	Delaware DOT; Maryland DOT; Long Island Rail Road; Portland, OR; San Francisco, CA; LA County Public Works	http://www.mro.com/corporate/products/maximo_benefits_facility.htm#1	Phone: (800) 244-3346; E-mail: mro_info@mro.com, mromarketing@mro.com
TRADAS	Chaparral	Traffic monitoring	NA	No	No	Oracle 9i/8i	NA	C++	Windows 95/98/NT (client); Windows NT Workstation or Server (server)	3	Wisconsin DOT, Missouri DOT, Delaware DOT, New Jersey DOT, Nevada DOT, Arizona DOT, New Mexico SHTD, Indiana DOT, Montana DOT; San Jose, CA	http://www.chapsys.com/products.html	Chaparral Systems Corporation PMB #746 3530 Zafarano Drive, Suite 6 Santa Fe, NM 87505-2609; Phone: (505) 438-7353; Fax: (505) 438-2017; E-mail: info@chapsys.com
VTRIS	Signal Corporation	Traffic monitoring	NA	No	No	Visual FoxPro 6.0		Visual FoxPro 6.0; MS Graph	Windows 95/NT	1	FHWA (promoter)	http://www.fhwa.dot.gov/ohim/ohimvtis.htm	David Jones; Phone: (202) 366-5053
Transportation Asset Management System (TAMS)	3M Company	Asset management, customer service management	Signals, signs, lighting, parking meters, guard rails, crosswalks, pavement markings, sidewalks, curbs, sewers, hydrants	NA	Yes	MS Access, MS SQL Server				2		http://www.3m.com/us/safety/tcm/products/tamsdemo-main.jhtml	Phone: (800) 533-1380; E-mail: tcm@mmm.com.
SAP Software Suite	SAP	Budgeting and Planning, Program/Project Management, Asset Management, Procurement Process Management, CRM, etc.	NA	No	Yes	NA		NA	NA	2	Santa Clara County, CA; City of Palo Alto, CA; Washoe County, NV; Collier County, FL; Pennsylvania, Florida, Arkansas	http://www.sap.com/solutions/industry/publicsector/	SAP America Inc., Strategic Planning & Support Office 3999 West Chester Pike Newtown Square, PA 19073; Phone: (610) 661-1000; Toll free: (888) 227-1727

Table 7. Cross Reference between Required Capabilities and COTS Products

	CANDIDATE PACKAGES																	
TEAMS Score (max 6)	**3**	**5**	**3**	**5**	**4**	**5**	**5**	**6**	**6**	**5**	**2**	**1**	**3**	**3**	**3**	**1**	**2**	**2**
System/Capability	**dTIMS**	**CartêGraph**	**Infrastructure2000**	**Highways**	**MaintStar**	**GBA Master Series**	**Agile Maintenance Manager**	**Kiva DMS**	**Hansen**	**Cityworks**	**Trns*port**	**PPMS**	**Geoplan**	**Maximo**	**TRADAS**	**VTRIS**	**TAMS**	**SAP**
MISTRE (Management Information System for Street Trees	1	1	1	1	2	1			1	1								
TARAS (Traffic Accident Reporting System)				1		1			1	2								
Street Inventory System	1	1	1	1	1	1		2	1	1								
Traffic Monitoring															1	2		
Construction Management							1				1	1		1				2
Capital Project Tracking											1	1						2
Maintenance Management		1	1	1	1	1	1	2	1	1				1				
Traffic Signal Management	1	1	1	1	2	2		2	1	1							1	
Inspection Management		1	1	1	1	1	1	2	1	1								
Resident Permit Parking / Curbside Regulation Management		2	2	2	2	2		2	2	1								
Sign Management	1	1	1	1	1	1		2	1	1							1	
Street Light Information System (SLIM)	1	1	1	1	2	2		2	1	1							1	
Right-of-way management	1	2	2	2	2	2		2	2	2								
Permitting Management		1	1	1	1			2		1								

6.0 Summary and Conclusions

This Technical Memorandum has compiled a large amount of baseline information that will be necessary to develop the high-level functional requirements document and project plan for TEAMS. This information includes:

- A technical description of the TEAMS architecture, including the method for integrating individual asset management applications, and for providing an enterprise, GIS-based data warehouse for data retrieval and management of the core spatial data;
- An inventory of existing applications that will either be part of the TEAMS landscape, or which need to be upgraded or replaced;
- Descriptions of the core enterprise asset data needs and application functionality of the key DDOT stakeholders responsible for asset management;
- Stakeholder priorities and concerns to be addressed as part of TEAMS; and
- An inventory of the leading commercial asset management products that could be included in the TEAMS implementation.

The overall conclusion from this body of information is that TEAMS is indeed a feasible undertaking and has the potential to achieve substantial improvements in both day-to-day as well as longer-term strategic asset management practices and policies. However, there are a host of challenges to be addressed, and difficult issues to be navigated – both on the technical side, and on the organizational and business process side. Based on the stakeholder interviews it is clear that demonstrating progress in a short timeframe is critical to the success of the project. This will required careful, creative, and strategic phasing of the different components of the project. The functional requirements document, which is the Task 2 deliverable, will be important for allowing different pieces of the TEAMS solution to move forward with a common set of ground rules that ensure that integration can be achieved.

It is also evident that putting technology in place will not yield the anticipated benefits without significant efforts on the human resources and organizational side. It will also not be the panacea for work flow and coordination problems which may exist. Successful introduction of new technology will require considerable time and effort across the agency – for education, training, consensus-building, business process modification, and adjustment of roles and responsibilities. A strong project management function also will be critical to quickly resolve the myriad conflicts and roadblocks that occur in a project of this nature. Task 3 (the Project Plan) will address the activities that need to occur to ensure that TEAMS proceeds on a successful track. Section 3.0 of this report provided examples of some of the specific considerations to be included in the Project Plan.

Appendix A

Stakeholder Interviews Discussion Guide

Stakeholder Interviews Discussion Guide

Interview Objectives

Each interview will last 60 to 90 minutes. The purpose of the interviews is to:

1. Review your current data sets, databases and applications.
2. Discuss your current business practices and how these may interface with the TEAMS vision and systems architecture (see diagram below).
3. Obtain your perspectives on issues related to the TEAMS projects and gain an understanding of how this project could add value to your business area.

Discussion Topics

Business Process

- Provide an overview of your responsibilities with respect to asset management: data collection, condition assessment, operations, maintenance, capital improvements, planning, budgeting, reporting.
- Provide a high-level description of your major work processes.
- Describe how the tasks you perform are dependent on other units (e.g., we need to get traffic data from TSA to create the HPMS file).
- Describe the ways in which other units are dependent on what you do for their work (e.g., we provide pavement management with a list of completed projects and they update their files with new pavement layer information).
- What do you see as the major issues and improvement needs in the areas of data management, software / applications and system functionality for your unit?
- Please provide copies of standard reports that your unit produces.
- Please provide copies of standard reports that you regularly receive from others.

Data

- What data related to assets do you collect or produce in this unit?
- What do you use to uniquely identify your assets or asset-related information (e.g., location reference, project number(s), item number, date)?
- What data do you obtain from other units?
- What data do you provide to other units?
- For data that you collect, describe the data collection process (frequency, method, processing steps).
- How would you assess the current adequacy of asset-related data for your business functions (quality, accuracy, currency, compatibility, ease of access)?
- What information is most critical to your current function?
- What additional information do you wish you had?
- Is there information you need from other units that you sometimes have trouble getting? (Describe)
- Please provide a list of the data elements that you maintain.

Software/Applications

- What existing specialized software do you use (asset management systems, project tracking, maintenance management, customer management, etc.). Explain how you use each software package (provide references to documentation).
- To what extent is existing software meeting your business needs – please describe any deficiencies / difficulties you have.
- What new software do you need, or are you planning to acquire – describe its function(s), and if one or more packages have been identified as likely candidates, please identify them.
- Do you currently use GIS / mapping software? If so, for what purpose? If not, what might you use it for if it were more easily available? Does your data have the location referencing that would be need to map it?
- Do you currently use the Street Inventory System data? If so, for what purpose?

- What desktop software tools do you currently use (e.g., databases, report writers, query tools, spreadsheets, statistical packages, drawing / drafting packages, other)?

- Do you make use of document management system (FileNET) capabilities?

Enterprise Asset Management (see TEAMS architecture diagram below)

- What do you hope to gain from an enterprise asset management approach? What aspects of TEAMS would be most helpful to you?

- What issues do you see that need to be addressed for enterprise-wide data sharing?

- Are you aware of specific data incompatibility problems that currently exist (e.g., use of different coding systems, different date formats, etc.)

- What issues do you see that need to be addressed for the development of enterprise applications that serve multiple business units?

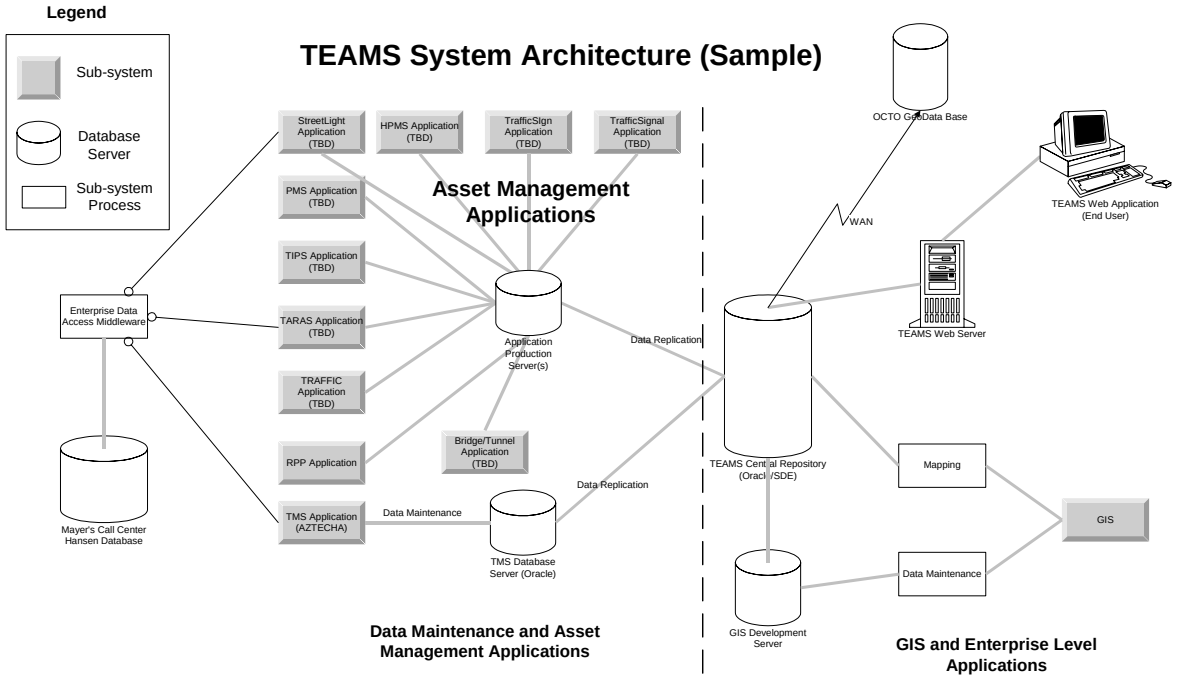
- Do you have suggestions for staffing, coordination, training or organizational steps that would increase the effectiveness of the TEAMS implementation?

Follow-Up Action Items

- Are there any other issues that need to be identified related to the TEAMS development?

- Are there any other documents or information sources that we should review?

TEAMS System Architecture



Appendix B

Stakeholder Business Needs

Stakeholder Business Needs

Business Area/Stakeholders: CFO – Budgeting

- William Lewis

Key Activities

- Compile Annual Capital Improvement Plan and the six-Year Capital Budget; have separate six-Year Program for right-of-way
- Track and update status of 2,000 active design and construction projects annually; $100 million in annual Federal funding must be matched with the D.C. portion of the Highway Trust Fund
- Maintain Federal Highway Obligation plan info and act as liaison to FHWA
- Receive and maintain local match derived from right-of-way program revenues ($37 million annually)
- Perform financial projections on operational side

Enterprise Data Needs

- Project status information (latest milestone status), including info on new projects from SOAR (System of Accounting and Reporting)
- Single source of project information (now info comes in multiple files, multiple formats)
- Database on project assignments by employee since staff time comes out of capital project budgets

Enterprise Data Produced

- Annual Capital Improvement Plan and the six-Year Capital Budget
- Info on obligations and pre-encumbrances from SOAR

- Info on expenditures by projects (through EIS reports)
- Info on operating budget in real-time from new module of SOAR

Current/Planned Applications

- SOAR – tracks pre-encumbrances, obligations, financial info on any project by phase
- EIS module of SOAR (expenditure by project info); new web-based data query makes extracting the info easier
- Procurement system being upgraded. New system, "PASS," will be linked with SOAR. Capability to handle change orders
- New personnel system TITUS to come online; also will tie into SOAR
- FMIS (Fiscal Management Information System) used by FHWA and DDOT to input SOAR contractor payments for Federally funded projects

Issues/Automation Needs and Opportunities

- Would like to be able to see what projects people are working on: 89 to 90 percent of DDOT employee salaries are funded out of the capital program. Need better checks and balances to make sure that only authorized people are charging to certain job numbers.

Business Area/Stakeholders: CFO – GASB34

- Ginny Grant

Key Activities

- Produce accounting/financial information, including GASB34 (mandated report on the value of city-owned assets)

Enterprise Data Needs

- For GASB34-expenditures by asset class roads and bridges
- Information to update composite depreciation rate. Need to determine historical spilt of work related to assets (e.g., how much streetscaping is done) to re-evaluate the composite depreciation rate that has been in use (increasingly, projects are combining multiple work types at once; hard to break out).
- Would like to obtain accident-related property damage data for city-owned property (e.g., people run into light pole) to be able to collect damages from the insurance company (info not currently captured)
- Would like system to pull project costs, then link with locations to obtain expenditures by ward

Enterprise Data Produced

- GASB34 report/asset valuation
- Financial/accounting expenditure data

Current/Planned Applications

- SOAR/EIS (includes broad categories of assets: roads, bridges, land, buildings)
- FMIS (Federal Highway Administration system) for Federal-aid projects
- RAPS (Rapid Approval for Payments System) for budget staff

Issues/Automation Needs and Opportunities

- System to support facilitating FHWA project closeout process to identify obligated dollars that would not be spent; completed projects with money left. For closeout, need: materials certification from engineer, final invoice, final inspection, final acceptance from FHWA, release from contractor, PR-47 (if over one million). System could track where they are and could help to identify these milestones to trigger the closeout process.

- Need to improve budget information in SOAR (problems with data transfer from the old accounting system; budgets not always accurate)

- Better linkages between accounting and budgeting (primarily an institutional/ organizational issue)

Business Area/Stakeholders: Contracting

- Jerry Carter

Key Activities

- Provide contracting support for DDOT highway/bridge construction services, traffic studies, etc.

Enterprise Data Needs

Enterprise Data Produced

Current/Planned Applications

- SOAR
- In the process of rolling out an automated procurement system (PASS); vendors have been working on it for the past eight months (Ariba software). In October, new rollout of procurement system (small purchase system) will interface with SOAR, will do acquisitions online, ascertain budget availability, allows lookup for vendors, links to supply schedule. Much of the contracting work is still done outside the PASS system; goes through Constra (for construction projects).
- The Construction Bid Analysis Module (part of AASHTOWare Trnsport) will require work with OSAT to implement bid tabs from previous projects (to get historical data to do future estimates); will be exclusively under responsibility of DDOT contracting office and OSAT.

Issues/Automation Needs and Opportunities

- Many contract documents are still manual
- Currently do not use GIS; not all projects have a location ID (locations may not be assigned immediately); have task number that will refer back to the contract number

Business Area/Stakeholders: Customer Service

- Karen Benefield

Key Activities

- Provide support to the administrations
- Functions as bridge to the Office of the Mayor – Neighborhood Services
- Operational arm of the office is called the "Clearinghouse"

Enterprise Data Needs

- IPMA service delivery information
- Work plans devised by Mayor's Office of Neighborhood Services Group – cover SNAPs (Strategic Neighborhood Action Plans), SNIPS (Strategic Neighborhood Initiatives), and PPAs (Persistent Problem Areas)
- Project info to input Neighborhood Cluster Database (NCD) – maintained in Mayor's Office of Neighborhood Services

Enterprise Data Produced

- Monthly report of correspondence received and assigned by division
- Neighborhood activity and community information input into the Mayor's NCD

Current/Planned Applications

- Serves (internal correspondence tracking system); also referred to as "DPW Serves")
- Hansen monthly report showing percentage of on-time service delivery for all sorts of assets: streets, sidewalk, alley repair, signs, lights
- Neighborhood Cluster Database (NCD)

Issues/Automation Needs and Opportunities

- Would like access to IPMA information (the service delivery aspect); right now communication is done over e-mail
- No querying capability on Hansen; can only make inputs and obtain static monthly reports
- Have to retype Serves information into Hansen in order to "get credit" for the work done and to feed the performance statistics (no link between the two systems)
- On-line reporting of correspondence received would be beneficial
- Would like location-based mapping and querying capability to see what is going on at specific locations

Business Area/Stakeholders: IPMA – Administrator

- John Deatrick

Key Activities

- Asset Management and Investment Strategy
- Design and Construction Project Oversight and Coordination

Enterprise Data Needs

- Past, current and planned spending by work type and asset type
- Characteristics and condition of assets
- Unit costs for different work types for each asset
- Scope and schedule for construction projects
- Data from construction process: estimated quantities, bid prices, built quantities, added items, construction duration, utility support activities (work done and time allocation), as-built drawings
- Planned TSA work (street lighting and signal program) and status
- Financial data (timing and status of key milestones in the process from encumbrance to closeout, burn rates, invoicing payment standards, change orders, claims, sources of funds)
- Utility work schedules
- Summaries of customer complaints by type and location
- Lists of potholes filled by location
- High Accident Locations (HAL)
- Traffic data
- Deficiencies and recommended improvement needs from TPPA efforts

Enterprise Data Produced

- Performance measures (project cost overruns / delays, deviation between construction project bids and engineer's estimates, street / pavement, sidewalk, bridge condition)

Current/Planned Applications

- Pontis™ Bridge Management System
- Paver Pavement Management System
- Culvert management system
- Tunnel management system
- SIS Inventory
- SIS / HPMS Reporting
- ProTrack (construction project tracking)
- Hansen call center
- Financial systems

Issues/Automation Needs and Opportunities

- SIS upgrade is a priority
- Would like to view a variety of data on GIS platform – e.g., HAL's from TSA, six-year construction program, street lighting and signal program work, bike trails, sign locations, etc.
- Traffic data, deficiencies, lists of improvements need to be geocoded and integrated
- Asset management should encompass both capital and maintenance investments in an integrated, coordinated fashion
- Need tools to help allocate resources across different assets and types of work for best value
- Need info system for existing and potential future locations for retaining walls
- Need to improve ProTrack capabilities – not linked to financial systems; hard to know how much was spent and what was done
- Need a project management system accessible to all, keep track of what asset was worked on, when, as well as change orders

- Would like web-based map with info on all construction sites, including contract status
- Traffic counts done by planning as part of studies should be in the right form for use in HPMS; should be part of consultant scope
- Would like web-based map of utilities information: what is there, what is planned
- Need better information on timeframe of tasks and final resolution
- Need to ensure as-built drawings get properly archived for easy retrieval
- Need to support more interactive (as opposed to linear) work flow processes for putting together the capital budget
- Systems to support work flow and improve coordination and communication across divisions (e.g., between project engineers and electrical inspectors)
- Need easier way to identify construction locations with electrical work. It is part of the PS&E documents, but not easily query-able (e.g., would like to produce from ProTrack a list of streets with work in progress including those with electrical work).
- Need systems to support better linkages between planning, design, and construction – accessible to all groups

Business Area/Stakeholders: IPMA – Design and Construction

- Konjit Eskender
- Samuel Olatunji

Key Activities

- Manage design projects
- Review plans and specifications
- Assist program managers in preparing and presenting projects to Advisory Neighborhood Commissions (ANCs)

Enterprise Data Needs

- Most significant areas are right-of-way, utility cut schedules, design plans, calculations, specs, and as-built plans
- Traffic design data from TSA
- Existing and future projects information
- Info on when roadway or bridge was last constructed, location of flood-prone areas, historical site locations, historic districts, NPS, utility cuts, right-of-way, etc (should be able to view from GIS)
- Access to bridge inspection report, load rating calculations, a map showing bridge numbers with descriptions or bridge names adjacent to the map
- Info from SOAR on how much has been expended on given project (the DDOT labor portion) since they charge time and need to know remaining budget resources
- DDOT design standard drawings and design manuals

Enterprise Data Produced

- Bridge and roadway: Design drawings and specifications
- Bridge and roadway project status reports
- Engineers' estimates, shop drawings, working drawings, change orders and task orders

Current/Planned Applications

- Spreadsheets kept on project status; one team member updates ProTrack
- PMS for pavement information (indirect user)

Issues/Automation Needs and Opportunities

- Need electronic project scoping procedures, design standard drawings and design manuals (make them web-accessible)
- GIS mapping capability to show recommended and planned pavement work from PMS within a five-mile radius, utility cuts (current and future), utility locations, right-of-way, bridge and roadway history (when it was reconstructed), historic districts, NPS, etc.
- No archiving mechanism or document storage mechanism for plans (design plan calculations / specs and as-built plans)
- Need standardized change order, task order, and project scoping procedures (can be done as a flow chart)
- Electronic capability to retrieve average unit price (electronic database) bids for engineering estimates (including updated pay item index)
- Standardized, electronic payment forms for all consultants
- Standardized construction project procedures

Business Area/Stakeholders: IPMA – Design and Construction

- Sylvester Okpala
- Mohamed Abdullahi

Key Activities

- Manage bridge and roadway construction contracts
- Coordinate with contractors for most pavement design work
- Work with IPMA – Pavement and Structure Management; get list of locations due for construction (resurfacing, reconstruction, upgrading) from the PMS
- Perform scoping, sometime collect additional data (e.g., core samples); then communicate back any changes in recommendations
- Plan to perform more surveying work once they get more equipment
- Coordinate with TSA – Traffic Safety on safety-related issues (TSA must approve the Maintenance of Traffic Plan)

Enterprise Data Needs

- Use pavement management system (PMS) and bridge management system (Pontis) data in the scoping process
- Asset / project life expectancy data
- Maintenance / work history information for given locations

Enterprise Data Produced

- Updated project status information

Current/Planned Applications

- MicroStation for drafting
- Excel spreadsheets to track individual projects

- Constra to input change orders and to compute payments based on daily inspection reports

- ProTrack to monitor / update project status and to plan for upcoming projects

Issues/Automation Needs and Opportunities

- Would like to see more coordination with maintenance (PMSA – Street and Bridge Maintenance) to prolong the life of the facilities that are built; intend to conduct scheduled preventive maintenance activities at well-defined intervals

- Automation of invoice approval process

- Standard scoping form; uniform design and construction procedures

- Would like to know the maintenance / work history for a location

- Better integration with Hansen and maintenance (PMSA – Street and Bridge Maintenance): customer calls about pothole, gets into Hansen, maintenance does temporary repair, but then they never get a request for a permanent repair; after some time passes, someone calls them with a Hansen reference number – they know nothing about it

- Need a standard form to track work requests of all kinds

- Sidewalk and alley projects not included in ProTrack; no way to enter a sidewalk location in ProTrack, since you need to put in a side of the street / address. Also, work that is more maintenance-oriented (different time scale) not handled well in ProTrack

- Need better communication across different project stages (e.g., with TPPA – not clear how results of studies filter in to the scoping process); and also with other units (e.g., Urban Forestry)

- Mapping of projects – both proposed and under construction

- Identification of historic areas / sites

Business Area/Stakeholders: IPMA – NHS/VMS Contract Mgmt

- Simon Rennie
- Greg Marshall

Key Activities

- Manage VMS contract for maintenance of all National Highway System (NHS) assets on the right-of-way (except signals and signs) – 75-mile system
- Track 170 performance measures per the VMS contract
- Manage VMS invoices / payments – including fixed and variable portions
- Ensure coordination with other DDOT work
- Participate in Clean City Program (206 sections on the NHS; emphasis on trash collection; identification of where / when trash needs to be collected more often)

Enterprise Data Needs

- Info from pavement, bridge management systems – condition, need, recommended work
- Identified deficiencies on the NHS from neighborhood planning efforts
- High accident locations, safety analysis for NHS facilities
- Scheduled capital work on the NHS
- Hansen system customer complaints
- TSA traffic control plans for NHS projects

Enterprise Data Produced

- Weekly Management Reports details accomplishments, current and planned activities for next 60 days by locations, asset categories, work types
- NHS maintenance deficiency information and timeframe for resolution

- Work needs off of the right-of-way (e.g., curb/sidewalk) that are noted in the process of performing other, non-related work
- Volunteer-generated reports on trash, graffiti (collected monthly as part of Clean City Program)

Current/Planned Applications

- Tracker (Access database) to track deficiencies and work – new web version being rolled out
- HQMS – a work order management system used by VMS
- DDOTAccess database to calculate payments
- Excel for Weekly Management Reports
- Prototype web portal that includes links to HQMS, Tracker, M.C. Dean's system, and contains discussion thread features

Issues/Automation Needs and Opportunities

- Web-based version of Tracker being implemented so that VMS and DDOT can share the same system
- Inefficiencies because VMS uses both Tracker and HQMS
- Timing lags as to when accomplishment info gets into Tracker
- GIS/SIS linked data; ability to extract wide variety of information by location, including condition of each asset/element and work tracking information
- Field data collectors, using wireless technology (GPS, PDA's possibly with some voice recognition features)
- Work deployment/management tools, (e.g., scheduling, routing) – provide feedback on the effectiveness of different deployment strategies

Business Area/Stakeholders: IPMA – Pavement and Structure Mgmt

- Derege Seifu

Key Activities

- Supervise pavement management program (collects pavement data and uploads it into PMS)
- HPMS reporting

Enterprise Data Needs

- Traffic data
- Hansen data
- Utility plans and permit info for PMS six-Year Plan development

Enterprise Data Produced

- HPMS
- Pavement condition data

Current/Planned Applications

- SIS / HPMS
- ProTrack for project indexing (linked to SIS; pulls info from PMS; data is exportable to Access and Excel)
- PMS (PAS / PAVER)
- GIS to plot projects (but limited in mapping pavement data)

Issues/Automation Needs and Opportunities

- Referencing pavement data to the SIS is cumbersome; could be more user-friendly
- Problems in compiling the HPMS; difficult to get traffic data into the system which must be updated and loaded by three divisions (design division, traffic division, and pavement management). All three divisions have access to SIS
- Need traffic data to be updated; would like to be able to use TIPS (Tracking Improvement Projects System) for project prioritization
- Priority would be to convert HPMS, PMS, and TIPS (Tracking Improvement Projects System) into a more user-friendly, Windows-based program
- System to support coordination with bridge and tunnel management and traffic (IPMA and TSA); also with right-of-way
- No access to utilities / street cut data and cannot get utility plans; need plans from utility companies to revise division six-Year Plan
- Would like to have GIS integrated (has made limited use of GIS in mapping pavement data; SIS ID numbers are the basis for all mapping)
- Change in business practices needed; data ownership needs more clarity (it's not clear who owns the data and who is responsible for updating it)

Business Area/Stakeholders: IPMA – Pavement and Structure Mgmt

- Mesfin Lakew
- Donald Cooney

Key Activities

- Asset Management: pavement, alleys, structures (bridge, tunnel, culverts, walls)
- Preventative maintenance (PM) contract management
- Produce inputs to capital program
- Responsible for HPMS and National Bridge Inventory (NBI) reporting
- Provide design and construction support for project teams
- VMS Asset Management for NHS contract monitoring / management
- Update the TIP (Transportation Improvement Program) portion of the SIS

Enterprise Data Needs

- Pavement management info includes: block / section ID, length, width, traffic history, layers, projected traffic, construction history, programmed work
- Bridge Management (Pontis) database includes: curb and sidewalk width, median type, road characteristics (on and under the structure, including number lanes, average speed, current and future ADT, percent trucks, accident count, detour length, detour speed, approach roadway width, roadway width, functional class, NHS, school bus / transit / emergency route
- Need clearer up-to-date agencywide understanding on which projects are in the Capital Budget. Tends to be dynamic, especially for local (ROW fund) projects

Enterprise Data Produced

- Pavement inspection data: cracking, roughness, condition index
- Bridge inspection forms, NBI ratings: Structurally Deficient, Functionally Obsolete, HBBR Eligibility (Rehab and Replacement). Specific deck, super, substructure, culvert ratings may be useful as well
- Federal NBI Report

- Priority list of bridges for major capital work (including type of work) input to capital program process

- List of bridges for preventive maintenance (have PM contract for deck repairs, temporary supports, etc.); starting large PM contracts for specific bridges, (e.g., TR, 11th Street)

- List of bridges for minor work – to be done in-house (now very short-staffed so this is minimal (would like to do more, e.g., deck sealing)

- Spending plan, scope of work for bridges submitted to Capital Budgeting (average costs per length or deck area used; derived from analysis of bid tab data from Contracting)

- Recommended priority list of pavement work (treatment type) by section (for Capital Budget)

- Future: inventory and condition info for tunnels, culverts, alleys, walls, sidewalks

- Alleys: starting alley contract now – inventory and inspection – they had estimated 335 miles of alleys; but the GIS map indicates 405. Alleys do not have names; will be identified by the four boundary streets. Will be dividing them up further into logical sections. May also be linked to specific parcels

- Culverts: Wilbur Smith is collecting inventory/inspection data now. Anticipating completion of the inspections at the end of the fall, but schedule could slip – some of the culverts are on park land, and permission is required for these inspections. Using GPS to locate culverts – recording the location of outfalls (point locations)

Current/Planned Applications

- Switching from PAS legacy in-house DOS-based system) to PAVER (both systems will run in parallel for one year)

- AASHTOWare Pontis version 4.1.1 for basic bridge inventory and repository of inspection data (will use 4.2 shortly)

- ProTrack – tracks all proposed roadway projects, identified by street, from and to (consistent with SIS). Tracks project status, but not actual costs. Major use is to track date of project completion; this is used to determine when to begin the moratorium period for permitting. Effort underway to merge Excel spreadsheet tool (Serge Louis) for contract tracking with ProTrack.

- SIS – sizepave, class, traff, hpms, curb, TIP (transportation improvement program), HPMS modules

- Culvert Management System: Implementing public domain culvert management system developed for FHWA, distributed by Iowa State LTAP (http://www.ctre.iastate.edu/pubs/Tech_News/2003/JanFeb/7_signs,culverts,intersec.pdf). System handles inventory, condition, work needs, work funding and work scheduling. Estimate 60 culverts, but may be more.

- Tunnels: D.C. is Test site for the FHWA tunnel management system developed by Gannet Flemming. Http://assetmanagement.transportation.org/tam/aashto.nsf/home?openform&Group=f.%20Tunnel%20Management%20Systems&tab=REFERENCEBYCATEGORY

Issues/Automation Needs and Opportunities

- Need SIS upgrade to Windows – top priority

- Need suite of applications supporting inventory, condition, prioritization, work management, work history for: pavement, bridges, tunnels, culverts, alleys, walls, sidewalks

- Would like systems to support capability to calculate overall index, covering multiple assets, for use in prioritizing streets projects

- Would like systems to provide support for tradeoff analysis across projects/asset types

- Mapping of all assets, including pavement, bridge, sidewalks, alleys, signals, street lights, etc. (they currently make extensive use of GIS, and will be getting their own GIS capability in place – software, plotter). Planometrics was overlaid on the centerlines, can already link all SIS data to the map. Do not have alleys in GIS yet.

- Improved information flow about work that occurs from maintenance (including investigations unit) back to IPMA (e.g., utility companies do paving, investigations unit inspects; need to report back). Same with alley and sidewalk work.

- Better information on what has been spent by location – this is a problem for multi-location contracts; would need to structure bid items to have separate quantities for each location

- SIS sidewalk data needs to be restored (old data was lost)

- New SIS needs to store alley information (now being collected)

- New pavement management system (PAVER) needs to be linked to the (upgraded) SIS – both as data source and as repository for key information

- Need to make sure culverts, bridges, tunnels have location referencing compatible with other assets for GIS integration. SIS ID not sufficient for bridge location, since

begin/end of bridge can be at midblock; need to be clear about definition of where begin/end is – perhaps need with and without approaches. Pontis stores latitude and longitude – single point locator for a structure, as well as HPMS-compatible linear referencing info (Inventory Route + km post). Pontis also stores structure length and total length (which includes approaches). Need to investigate whether current bridges have accurate location information.

- Need identified for retaining wall system, to include existing walls plus locations where new walls are needed; no effort on this yet.

- Impact Attenuators: TSA supposed to maintain inventory of safety hardware; need to share info with IPMA since they would manage construction projects to install new attenuators. Project was started but not ever completed to create attenuator inventory and develop list of additional needed locations.

- Need to create triggers in new systems to replace (and improve) SIS TIP functionality – when capital project is completed, resets condition, automate process of making necessary updates to other information (layers, work history, dimensions, curb/gutter and sidewalk characteristics, etc.)

- Effort underway to see how Pontis could be used for program development purposes – currently used for data storage and reporting only.

- Need better tools for supporting resource allocation process, particularly for local projects. Now, council requests get highest priority, then look at the number of citizen requests per location, consider balancing across wards, and SNAP requests.

- Ensuring accurate, up-to-date data in ProTrack has been an issue – especially maintaining accurate estimated project start dates.

- Need to get access to all traffic data collected by DDOT – including data from special studies – for incorporation into HPMS.

Business Area/Stakeholders: IPMA – Project Tracking/Contract Mgmt

- Serge Louis

Key Activities

- Manage approximately $200 to $350 million annually in contracts
- Provide payments to contractors/consultants
- Provide input for capital project planning
- Coordinate with IPMA team leaders regarding project approvals
- Track internal project budgets
- Track budgets for the Eastern Federal Lands Highway Administration, which acts as a design-build consultant on projects

Enterprise Data Needs

- Accounting information from SOAR on actual expenditures
- GIS-based or location-based linkage to be able to classify projects by ward
- Project tracking system that tracks retainage amounts based on percent completed, flags approaching close-out phase and associated tasks, and has ability to make projections to feed into capital planning process

Enterprise Data Produced

- Purchase orders (original goes to contractor; other goes to CFO Office)
- Excel-based monthly department-wide report on division projects; contains project status by project number (Federal project number or D.C. project number), contract amount, project name, change order, percent of change order of original contract amount, year-to-date contract amount, expenditure to date, payments against contract amount
- Excel-based monthly report on Eastern Federal Lands Highway Administration; contains how much money they requested, how much was given, how much was expended
- Excel-based projections for capital budgeting

Current/Planned Applications

- Constra (contains tabulation of bids, percent complete, amounts, items, units costs, grand total); used by inspectors to get daily reports of construction activity
- Excel spreadsheets for budget and performance reporting

Issues/Automation Needs and Opportunities

- Would like contractor to use same software as DDOT (currently contractor does not have access) so that both DDOT inspector's and contractor foreman's tabulations of work performed are the same and reconciliation process is cut down
- Would like linkage to SOAR because, on program management side, does not know what is going on with expenditures. Project management system does not connect with financial system
- Would like project tracking system with intelligence to apply correct retainage amounts (these fluctuate throughout project) based on percentage completion; ideally system would recalculate figures based on retainage credits and keep the budget current
- Would like capability to produce monthly financial report of projects by ward (has no capability to do this; does not use GIS)
- Payment process and project tracking systems vary by division; one uniform payment system process and project management system needed
- Challenge in timely project close-out; tracking system should have intelligence to provide a flag that contract should be closed and certain tasks need to be completed beforehand

Business Area/Stakeholders: PSMA – Administrator

- Lars Etzkorn

Key Activities

- Strategic management / oversight of public space maintenance function
- Bridge and street maintenance (bridge / ward foremen / milling and paving teams, signs and markings). Beginning to conduct crack sealing (road surface treatments). In the future, would like to do chip seal, microlayering, and implement timed replacement for street signage, markings (using life-cycle approach, with sampling to test actual life)
- Inspections
- Permitting
- All work done in-house except for sidewalks and alleys contracts, and NHS contract (VMS contract administered by IPMA)

Enterprise Data Needs

- Pavement / street / signage / markings inventory, asset condition information, and historic (condition trend, work history) information from IPMA (need better info on signage and markings)
- GIS-based right-of-way info that displays how the ROW is divided, along with geographic placement of signage, markings, underground utilities, lights, signs, signals (will answer questions as to where all the fences are, where the revenue-producing vaults are, whether sidewalk cafés are operating within the scope of permit and whether they are properly constituted, etc.)
- Accounts receivable info from CFO Office (to correlate with rental payments for underground conduits, street cafés, dumpsters, and to ensure rent collected is appropriate)
- Historic weigh-in-motion data (TSA)

Enterprise Data Produced

- DDOT-wide performance measures reporting
- Supplemental measures reporting (e.g., 10 percent reduction in pothole complaints)
- Permit issuance
- Distribution cards that divide right-of-way in public space (hard-copy, static format; have been scanned in and available electronically)
- Updates to Hansen – disposition of customer issues

Current/Planned Applications

- Hansen
- SERVES
- In-house Access database to track inspection activities
- Routing-based software with AVL system for snow vehicles (in procurement process) to be tied to about 100 snow vehicles for 2004 season

Issues/Automation Needs and Opportunities

- Since PSMA is largest employer within DDOT (250 people), very interested in tools to help monitor work flow; tools needed to track daily inspection activity
- Systems to support preventative maintenance activities, timed replacement program for signs and markings. Would like to be able to track age of different components and prioritize preventative maintenance resources (now done on ad hoc, complaint basis, or internally initiated by a department employee)
- Use GIS to overlay right-of-way distribution card info with underground assets, street lights, and street signs (this would be very useful in permitting)
- More accessible, accurate street inventory information
- Would like the ability to correlate demands for maintenance (via customer calls) with actual conditions
- In Hansen, complaints should be logged against the particular asset; follow-ups recorded; currently cannot query system to see all issues related to a particular asset / location, and follow-up actions not always entered

- Systems to support better information sharing about work plans and activities between maintenance and construction

- Systems to support better coordination with TSA regarding parking permits/ regulations

- Would like to move to web-based permitting (80 percent of permitting activity is accounted for by 14 customers). For other 20 percent, perhaps web would not work, but would like to have standard paper protocols, electronic transfer from here. FileNeT with automated work flow is an option

Business Area/Stakeholders: PSMA – Inspections

- Daniel Harrison

Key Activities

- Oversee compliance and permitting (e.g., to ensure that the street is put back in its original condition)
- Issue violations to those who did not finish work within the permit timetable
- Assist Urban Forestry staff
- Check street signs and traffic signs

Enterprise Data Needs

- Citizen complaints from Hansen
- Permit information (Permitting – PSMA)

Enterprise Data Produced

- Violations reported to DMV for adjudication
- Most info is referred to IPMA for permanent repairs or to PSMA – Street Maintenance for temporary repairs (through e-mail; interpersonal communication)

Current/Planned Applications

- In-house Access database used to track their work by permit number
- Hansen to obtain citizen complaints
- Deposit database used to track when deposits are made and when monies are released from obligation (part of permitting process)
- Route Smart is a candidate application to route work orders among field staff; paired with AVL in vehicle

Issues/Automation Needs and Opportunities

- Data sharing with PSMA-Permitting to avoid duplicate manual entries of permits
- Greater info sharing with IPMA about recent paving activities that are relevant to their permanent restoration work (to avoid redigging pavement)
- Software needed to interface with field staff (similar to a PDA system that Urban Forestry staff are using)
- Would be helpful to share information agencywide on violator contractors (in terms of signage, curb cuts, etc); not sure who collects this
- Info needed on location of signs, streets, meters
- Need systematic way to cover all streets in each ward (routing application to route inspectors); Route Smart application is a candidate
- GIS-based mapping of complaints, location of construction activity, etc., needed
- Need better work-flow reporting tool for inspectors

Business Area/Stakeholders: PSMA – Permitting

- Denise Wiktor

Key Activities

- Permit issuance (surface and subsurface)
- Manage about $30 million of annual revenue (from underground vaults, cafes, etc.)

Enterprise Data Needs

- Info on which roads have five-year moratoria on street cuts from ProTrack system – IPMA
- Info on planned construction activities from IPMA, TPPA (commissioned transportation or planning studies), Capital Budget Office
- Info on street lights (TSA – Street Lights), including when newly installed lights come online
- List of parking meters (TSA – Curbside Management), as well as the revenue they collect so they can calculate the opportunity costs when meters are blocked
- GIS mapping of location, size and dimensions of sidewalk cafes (list of sidewalk cafes should be matched against billing cards and plans to obtain accurate picture of size and configuration)
- 3D view of underground facilities

Enterprise Data Produced

- Permits and related maps
- Scanned distribution cards which divide public space and illustrate right-of-way – show distributions of road, tree box, sidewalk, public parking; do not contain underground utilities or water information
- GIS-based utility plans (provided by utilities every two years); inaccurate relative to public space distribution (because scanned cards are static and have not been updated)

Current/Planned Applications

- The surface unit uses an Access database; the subsurface unit uses Permitting Hansen
- One part of permitting division uses Permitting Hansen module; the other part (DCRA – Dept. of Consumer and Regulatory Affairs) uses Excel spreadsheets for permit entry

Issues/Automation Needs and Opportunities

- Problems include accessibility to DPW Net for entire division; accessibility to Hansen limited for a part of division due to old age of computers
- Manual billing systems for cafes and vaults with no interface with accounting information on collected rent
- DCRA has historical permitting data that needs to be migrated (now Permitting has no access to this data)
- DCRA still manually types the permits, so only minimal information is entered in (data quality issue)
- Would like own server, hardware, and Hansen module (separate from DCRA's, but one that will talk to the DCRA system through middleware)
- Data in hard-copy distribution cards is locked into three-year old images; static
- Surface permits, assignments, distribution cards need to be updated
- Street construction inspectors do not have access to their permitting software
- GIS is inaccurate relative to public space distribution

Business Area/Stakeholders: PSMA – Street and Bridge Maintenance

- Robert Marsili

Key Activities

- Roadway surface maintenance (including signs, markings, potholes)
- Permanent restoration of street cuts
- Minor bridge maintenance
- Manage maintenance contracts
- Ensure that VMS work under the pilot project (comprising 70+ miles of National Highway System) is clearly delineated from work done by group's own contractors; and ensure that VMS work gets properly closed out in Hansen
- Adhere to work zone rules (via paper files / records)

Enterprise Data Needs

- Hansen customer service requests (main source for work repair activities)
- Work orders from TSA for signs and markings upon completion of safety reviews
- Permit numbers of projects for which permanent restoration of street cuts is performed
- Centrally located, accessible information on personnel (to keep track of field staff)
- Pavement info from the pavement management system (PMS) for preventative maintenance activities
- GIS-based parcel maps to determine limits of public space and right-of-way location (demarcate lines of responsibility)
- Pavement plans from IPMA – Pavement and Structure Management for those alleys and streets that are programmed in the six-Year Capital Plan (to learn about ongoing projects that span a long timeframe)

Enterprise Data Produced

- Input into Hansen related to in-house, contractor, and VMS work activities

Current/Planned Applications

- Hansen Call Center system drives all work requests for road maintenance (and all activities get input into Hansen)
- In-house Access database for permit tracking on inspections side
- Plan to procure a GPS/AVL system for snow truck routing for 2004 snow season

Issues/Automation Needs and Opportunities

- Support for improved coordination with IPMA regarding pavement activities
- Support for permitting process (traceability of permits through several work cycles is very difficult). Need better tracking of permits during initial and secondary phases of project where Permitting (within PMSA) performs initial work and then permanent repair is completed by Bridge and Street Maintenance.
- Improved interface with TSA and their investigations
- Improved interface with the signs and markings staff
- Improved coordination and work tracking within PSMA – Street and Bridge Maintenance; currently use paper work orders. Would like system for centralized tracking of field staff activities – GIS interface, ability to generate maps of activity, preferably classified by wards or Advisory Neighborhood Council (ANC) areas
- Need for better interagency sharing of what tools/systems are currently out there
- Improved interface between Hansen and IPMA system – currently done through hard-copy reports only since IPMA does not have a responsibility code in Hansen because they perform long-term work
- Better interface between SIS and Hansen street repair system
- Maintenance contractors have no access to Hansen or to related VMS activities (contractors cannot close out activities in Hansen directly)

Business Area/Stakeholders: Strategic Planning

- Michelle Pourciau

Key Activities

- Strategic Planning for DDOT

Enterprise Data Needs

- Timely, location-specific project information to respond accurately to public, Council Member, Mayoral inquiries (information requests are so diverse as to cover info from all DDOT divisions; e.g., TSA, IPMA, PSMA)
- Performance measures for each division

Enterprise Data Produced

Current/Planned Applications

Issues/Automation Needs and Opportunities

- The SIS upgrade is the top priority – upgrade to Windows platform
- Need basic asset information by map-based query – e.g., go to DDOT website, click on an intersection, and find basic information
- Need up-to-date, accurate project status information with location / link to GIS
- Need management tools for reviewing data and performance; need an executive decision support system with user-friendly GUI
- Need to tie financial systems into TEAMS
- More use of / training in Microsoft Project

Business Area/Stakeholders: TPPA – Administrator

- Ken Laden

Key Activities

- Strategic management / oversight for planning administration
- Perform ward-based planning activities
- Interface directly with residents, developers, contractors / consultants, and other stakeholders
- Research and answer inquiries from constituents, Mayor's Office, DDOT Officials, ANC Commissioners and other stakeholders
- Review and provide input on zoning cases and forward copies to TSA – Safety for comment
- Provide input to streetscape plans
- Provide quarterly updates to SNAPs (Strategic Neighborhood Action Plans), SNIPs (Strategic Neighborhood Investment Plans), and PPAs (Persistent Problem Areas) which are under Mayoral directive
- Commission location-specific traffic studies (result in long-term action lists; capital construction) and traffic calming studies (result in short-term action lists; typically maintenance activities)
- Serve as conduits of information flow to Capital Budgeting division
- Produce Monthly Performance Measurement Report (Mayoral scorecard)
- Produce Performance Measures tracking worksheet
- Working on a reporting system with the Feds on an annual and quarterly basis (still finalizing report needs / requirements)
- Produce weekly status reports for projects (for Director / Associate Director)
- Produce Front Burner report (requires coordination of Mayor's Office)
- Produce Federally mandated fuel consumption report (some of that info comes from other agencies)

Enterprise Data Needs

- Permit info from PSMA – Permitting so they know if someone is in violation of permit
- Parking regulations and restrictions (TSA – Curbside Management)
- Info on tree locations for streetscape plan input; also maintenance / removal / pruning activities (Urban Forestry)
- Traffic data (TSA – Safety)
- Projects programmed in Capital Budget (pending and future), organized by ward
- Capital spending plan (Excel-based)
- Generally, anything they may be asked about in a public forum

Enterprise Data Produced

- Neighborhood transportation studies and traffic calming studies (IPMA, TSA, PSMA would be interested)
- General planning studies / reports (would be of interest to TSA and PSMA)
- Planners serve as conduits for citizen input / feedback to other DDOT divisions (info passed orally or via e-mail)
- Inputs into SNAPs, SNIPs, and PPAs (Mayor's office interested in this)
- Fuel report
- Performance measure reporting

Current/Planned Applications

- Use GIS for defining project areas, accessing some info on characteristics of the road-ways, mapping
- Have some limited access to the Capital Budget
- Have access to ProTrack but not user-friendly / accessible, not classified by ward
- Use word processing and spreadsheets for most work

Issues/Automation Needs and Opportunities

- Currently, there is a great reliance on interpersonal communication skills; a lot of information flow could be automated
- Need to more systematically integrate SNAP and SNIP commitments into Capital Planning / Budgeting (tie together by project location)
- Although IPMA is tied into the project management model that of integrating neighborhood interests into Capital Budgeting, TSA and PSMA are not
- Would like to link Capital Budget priorities to projects out in the field (to get better feel of the relationship)
- Capital Budget info gathered by request; not systematically. It is often untimely and in static format; cannot import or download
- Capital Budget shows projects still pending, when some are completed (problems with feedback)
- GIS overlaying of different divisions' data. Ideal situation would be to click on a block in a map and get the physical characteristics of the block and budget info
- Need system for tracking maintenance requests so Ward Planners could check on a complaint and report back (not sure if they have access)
- No formal project tracking system (e.g., to incorporate the dates of imminent and future zoning hearings and provide ability to track, follow through, and ensure funding availability for projects in future years)
- Need uniform database management system
- Need better process flow for review, sign-off, and follow-through of electronic punch list from neighborhood transportation studies and traffic calming studies
- Would like to look at "the big picture" from individual resident requests that result in piecemeal work on only portions of blocks (there are instances where this fragmented approach should have been replaced with a broad stroke over an entire street route)
- Better integration of zoning (to inform and get TSA – Traffic Safety feedback), curbside management, and trees data (for input on streetscape plans)
- Better link to PSMA – Permitting so planners are aware of violations and can report back to citizens

Business Area/Stakeholders: TPPA – Capital Budgeting/ Performance Reporting

- Emeka Moneme

Key Activities

- Build Federal obligation plan (obtain Federal apportionments / allocations and do estimates for future years)
- Develop DDOT Capital Budget (Annual, six-year, and recently eight-year timeframe) – act as liaison to TPPA which submits project requests
- Update project information in central capital projects database within the Central Budget Office (OBP)
- Assemble Weekly Performance Report for DDOT

Enterprise Data Needs

- Project requests, estimates, scope, plans
- Inputs which allow for prioritization from several sources (planning, traffic engineering, maintenance crew staff)
- IPMA project information, including monthly exception report concerning change orders
- Historical spending patterns by asset type and location
- Performance measure inputs from different divisions for consolidation into weekly and monthly management reports

Enterprise Data Produced

- Annual and six-Year Capital Budget documents
- Status of capital budget (much of this information now provided via phone communications)
- Obligation Plan for each FY, as well as a six-year and eight-year view (recent development)

- Exception Report for Policy and Planning (Excel-based); project management data and change orders; posted to the intranet
- Spending update for Local Capital Program
- Weekly Management Reports
- Monthly Performance Report (compilation of info from Hansen Call Center, Azteca tree system, pavement management system, TARAS, exception report, signs)

Current/Planned Applications

- SOAR and EIS (new online budgeting module)
- Access database of all D.C. capital projects; maintained by D.C. Office of Budget and Planning (OBP)
- Indirect user of Hansen, Azteca, PMS, TARAS – divisions use these systems to generate performance measures

Issues/Automation Needs and Opportunities

- Need to address linkages of financial information (e.g., obligations) to projects for mapping purposes
- Better process for coding of project locations in the capital budget – location information not always there
- Automated connections between SOAR data and capital budgeting database (now must extract data from SOAR with EIS and retype)
- Need good capital project management tool (e.g., Primavera); for budgeting, scheduling, milestones
- Better linkages between planned projects and projects in implementation stage (cradle-to-grave traceability)
- Need centralized filing system, improved document management capabilities (to be addressed via FileNeT)
- Need to have better backup information on projects in the program (including plans)
- Need better connections with the Central D.C. OBP project database – this is where program updates occur

- Capture of information from newly created electronic budget forms – "Program Action Plan," "Form 106," "Form 300b" – to a database

- Need easier way to determine historical expenditures by asset and location – e.g., to answer a question like how much was spent on bridges connecting D.C. to Virginia. Expenditures are tied to projects, not assets – must use CFO office ledgers with hand-written information on appropriation codes and spending

- Need sign inventory – now comes from hand-maintained logs from TSA – Curbside Management

Business Area/Stakeholders: TPPA – Mass Transit

- Alex Eckmann
- Gilbert Williams

Key Activities

- Manage relationship between the City's interests and WMATA (strictly administrative)
- Provide financial, policy, and administrative functions relative to WMATA, which owns and maintains all assets
- Manage the bus shelter program (400 bus shelters) on an exception basis (use contractors to fix problems)

Enterprise Data Needs

- Electronic (preferably GIS-based) inventory of bus shelter locations; not even WMATA has that, and they get all their data from WMATA
- Electronic (GIS-based) info on bus routes since traffic maintenance plans have implications for routing (however, they get only limited permit requests that necessitate this)
- Info on any activities that can impact bus routes (construction / maintenance activities, temporary street closures, etc.)

Enterprise Data Produced

- Bus routes and stop information (from WMATA)

Current/Planned Applications

- Hansen – customer complaints
- Access database to store info on bus stops and text-based bus stop description; location described by street name and direction (not using GIS or SIS)

Issues/Automation Needs and Opportunities

- Automated, GIS-based maps and inventories of bus shelters and bus routes. Bus stop inventory done by WMATA, which has an Access database (under development) to

try to identify every bus stop. Location used is the street intersection; also a text-based description of the surrounding area is included. Database does not use the SIS for location; has its own coding for city block. Bus stop assigned to separate pole or traffic sign.

- Role in TEAMS limited; WMATA owns all assets and provides analytical capability on ridership, transit planning, etc.

Business Area/Stakeholders: TSA – Administrator

- William McGuirk

Key Activities

- Strategic Management / Oversight of Traffic Safety function

Enterprise Data Needs

- Greater integration of location information / mapping (for example, to see if top 40 accident locations change over time)

Enterprise Data Produced

- Volume, speed, locations of signs and pavement markings, info on street light locations, signal sequencing, physical hardware in the city, police accident reports (general traffic engineering needs)

Current/Planned Applications

- TARAS
- Geo-Imaging Consulting, Inc. performed some work on a project tracking system for TSA (project on hold; contracting issues)
- TSMD – large database is of signals data (contains history of malfunctions that indicate when things were replaced; a lot of the records are litigation-based)
- An intersection history database
- Limited use of GIS for accident / AADT mapping

Issues/Automation Needs and Opportunities

- TSA shares more data than they obtain from others, so there is a wealth of information that other divisions would be interested in. Most of their needs come from improving their own business processes and methods of storing, sharing, and managing data. For example, traffic regulation information is physically stored in binders and not in

accessible form to other groups, like TPPA who need it for zoning cases (thousands of pages of rationales exist for one-way streets)

- Need consistent project tracking system across all DDOT agencies (currently unstandardized). Different definitions of "project" exist – need to clearly define classes of projects and delineate all of the steps that a project goes through (from initiation through approval process through design/construction)

- Centralization/standardization of data relating to underground infrastructure, signs, pavement markings, signal sequencing, and volumes (currently kept in different offices in different databases)

- Would be helpful if IPMA can get easily accessible info on pavement markings, signals. When IPMA initiates projects, they need certain data to obtain Federal approvals (e.g., volume data and speed estimates); Would be helpful if contractors could access such data for their work

- Reporting of incidents/accidents and electronic reporting of "PD 10s" so that TSA clerks do not have to manually enter the information into TARAS

Business Area/Stakeholders: TSA – Curbside Management

- Jean McCall
- Anthony Jackson

Key Activities

- Traffic Operations branch – deals with rush-hour restrictions, traffic regulations, signs and sign maintenance (all streets), pavement markings, stop signs, truck and bus restrictions, one-way street regulations / restrictions

Enterprise Data Needs

- Street light plats from TSA – Street Lights
- Street sign info from TSA, PSMA
- Hansen requests (about 1,500 monthly)
- Serves requests

Enterprise Data Produced

- Hard-copy dockets on parking and traffic regulations / restrictions
- Drawings and information related to restrictions / regulations and markings

Current/Planned Applications

- Hansen for work requests / complaints
- Serves for written requests
- Curbside Master Database (CMD) – in-house Access database for tracking activities; contains own ID number for work order, Hansen ID number, date submitted, location, due date; info can be queried by ward
- Miss Utility clearinghouse service used before drilling activity
- GIS aerial maps to locate intersections and pull up photographs of markings (viewing capability only)

Issues/Automation Needs and Opportunities

- Traffic regulation info is in binders (not in electronic, on-line format)
- Work orders manually filed (no electronic filing system)
- Would like info on street lights (TSA – Street Lights), street signs (litigation issues occur if, for example, a street sign is missing after street light is removed and replaced)
- All drawings will be stored in data management system (consultant working on this)
- Not using SIS for location
- Greater coordination with construction needed
- Manual inputs into Hansen needed to feed performance statistics and to get credit for work performed

Business Area/Stakeholders: TSA – Signals

- Kamal Hamud
- Kim Walker

Key Activities

- Operation and management of 1,500 traffic signals in traffic control center
- Perform signal optimization
- Ensure communications infrastructure with signal controllers is intact
- Special projects – installation of detectors, traffic monitoring cameras

Enterprise Data Needs

- Traffic volumes by time of day
- New development construction plans – requiring new signal installations (TPPA)

Enterprise Data Produced

- Physical locations of traffic signals and CCTV (provided to GIS)
- Information on signal project status to public via community meetings (coordination with Ward Planners in TPPA to interface with public)

Current/Planned Applications

- Signal controller software
- SIS

Issues/Automation Needs and Opportunities

- Right now, controllers not collecting traffic data and volumes; group is trying to make them functional again
- Link Traffic Management Center (TMC) data to new Traffic Monitoring System (TMS)

Business Area/Stakeholders: TSA – Street Lights

- Nurul Hague
- Abdullah Fatah, Electrical Permits and Investigations Branch
- Michael Dorsey, Street Light Branch

Key Activities

- Permits, monitoring of utilities, construction and operations, street lights (design and maintenance – upgrades, repairs)
- Coordinate with M.C. Dean (maintenance contractor); have contractor to handle knock-downs also
- Ad hoc night time inspections (used to have regular night time inspections; hope to reinstitute this)
- Scheduled replacement for certain types of lights

Enterprise Data Needs

- Effort needed to identify city-owned underground infrastructure at a minimum
- Central database of planned work items
- Centralized system that contains as-built drawings for new projects
- On-line inventory system for warehouse facility that stores division equipment (so they know when they need to re-order supplies or what they already have)
- McSLIMS and other M.C. Dean database on work performed by M.C. Dean
- Design and as-built drawings for new projects (IPMA – Design and Construction)
- Signage inventory (so signs can be replaced to original light pole location if pole is replaced)
- Info on emergency work by IPMA
- Info from PSMA – Permitting on permits issued for subsurface work

Enterprise Data Produced

- Data on outages through SLIMS; could be used to determine performance measures
- Schedule of dig sites faxed daily to IMPA hard surface inspector and PSMA – Permitting
- Street lighting plats showing type of pole, how fed, light source, wattage, voltage

Current/Planned Applications

- Hansen captures 60 percent of complaints from citizens
- SLIMS is used for work orders. Contracts are pay item-oriented
- GIS to produce street lighting plats
- Constra used for billing
- Pilot program on 200 "pennant" lights using "Teletrix," a device on photocell whereby sender unit transmits to web site. Could get quick report on which lights are out

Issues/Automation Needs and Opportunities

- Hard to identify problems underground (location maps would help with this); now have outdated info; lack of information sharing between utilities (PEPCO) and water and sewer (WASA)
- Lack of connectivity between M.C. Dean version of SLIMS (McSLIMS), in-house SLIMS, Hansen, and M.C. Dean internal database (this is most up-to-date and accessible via web). Hansen requests cannot be electronically transmitted to McDean (they are faxed and M.C. Dean inputs into their own database). Must print info from McDean and re-enter it into SLIMS. Need to automate flow from DDOT to M.C. Dean to Utility to Hard Surface Repairs (flow is totally paper-based). Trying to make SLIMS web-enabled but OCTO firewall is a problem (timeframe perhaps seven to eight months).
- Design drawings are mostly paper-based
- Forty-five to 50-day lead time for conduit repair; need single source of info on what issues are open
- Coordination between IPMA emergency work and PMSA – Permitting may help multiple ripping of sidewalk because a conduit is hit during the first repair job and subsequently needs fixing

- Stronger linkage between light poles and signage on top of light pole; when one gets replaced, so should the other (problem with missing signs)
- Coordination of responsibility with Urban Forestry; when tree obstructs a light, TSA – Street Lights staff must trim tree (not Urban Forestry staff)
- GIS mapping system to tie lights to address / position; would like to retrieve maintenance history, problems for a given time period
- Would like new projects to record what is underneath the road
- Need for project tracking system to trace flow of event through its resolution

Business Area/Stakeholders: TSA – Traffic Safety

- Abdul Sleemi

Key Activities

- Traffic data collection and analysis (including cars, trucks, weigh-in-motion sites)
- Pedestrian safety analysis
- Review of permit applications and construction plans for safety impacts
- Work zone safety
- Preparation of traffic data for HPMS reporting
- Historical analyses on 100 locations identified as "high accident locations" (including costs of accident, existing traffic on accident locations, and change in conditions over time)
- Develop counter measures for high accident locations
- Produce AADT maps and annual high accident location map using GIS
- Minor work (marking, signage) done in-house

Enterprise Data Needs

- Planned and Programmed Work Status (to coordinate safety measures)
- Permit applications – for coordination of safety reviews
- Plans at 30 percent, 65 percent, 95 percent for safety reviews
- Signal timing information (currently paper)
- Intersection geometrics
- Safety-related customer complaints and correspondence

Enterprise Data Produced

- Annual AADT map
- Traffic counts
- Reports on accidents by type, location, and time of day (from police accident records)

- Priority listing of 3,000 to 4,000 accident locations
- Traffic trends
- Accident trends

Current/Planned Applications

- TARAS
- GIS for mapping traffic and accident data
- Accident Information Management System (AIMS) collision diagram software
- TMS / H (Traffic Monitoring System for Highways) – future

Issues/Automation Needs and Opportunities

- Manual entry of accident data from police is very time consuming; need to collect electronically
- Accidents not located precisely; only to nearest intersection (for the interstate system, location recorded as distance from given intersection)
- Further automation of HPMS reporting
- Automated production of the AADT map (requirement for the TMS)
- Electronic work flow for permit and design review

Business Area/Stakeholders: TSA – Traffic Safety

- Peter Moreland
- Yusuf Aden

Key Activities

- Traffic data collection, processing and analysis
- Weigh-in-motion data analysis
- Accident data entry (TARAS) and analysis

Enterprise Data Needs

- Signal timing information by intersection
- Traffic counts included in TPPA studies: locations, truck volumes, passenger car volumes, pedestrians, bicyclists
- Additional information from police on fender-benders, incidents, and overweight truck citations (not currently provided)

Enterprise Data Produced

- Annual Traffic Volume (AADT) map
- Speed, volume, classification counts by location and time of day
- Intersection level of service and volume/capacity ratios
- Pedestrian counts
- Intersection turning movement counts
- FHWA-required traffic monitoring data: monthly weigh-in-motion (WIM) data, average weekday traffic by count station

Current/Planned Applications

- TARAS for accident reporting
- SIS for AADT calculations for HPMS

- ArcGIS 8.3 for mapping AADT and accident data
- AIMS collision diagram software
- Excel for manual counts at permanent count stations
- VTRIS (Vehicle Travel Information Systems) software for exporting monthly WIM data reports to FHWA
- Traffic Monitoring System (planned)

Issues/Automation Needs and Opportunities

- Automation of police accident reporting
- Capture of incidents and fender-benders in police accident reporting
- Greater coordination with police over enforcement of overweight vehicles
- Would like TARAS info to be web-based and user downloadable (other interested users may be IPMA, TPPA planners, Traffic Signal division)
- Would like mapping capability for manual traffic counts
- Centralization of traffic data in one place
- Prioritization of pedestrian count locations

Business Area/Stakeholders: Urban Forestry

- Ainsley Coldwell
- Wanda Polite

Key Activities

- Emergency tree response (about 12,000 responses annually)
- Tree Removal (2,000 trees annually)
- Tree Planting (4,000 trees annually; maximum 5,000 annually)
- Tree Maintenance / pruning (17,000 trees annually)
- Ginkgo tree spraying
- Micro injections for elm tree disease
- Issue permits for planting, pruning, and removing trees
- Manage on-call and contract staff
- Manage D.C. Green Grants Program to fund local urban and community forestry activities (partnership between DDOT, USDA Forest Service, and District of Columbia)

Enterprise Data Needs

- Have access to a number of layers in GIS (e.g., sidewalks, utilities); important to update this information since removal of sidewalks has implications relative to planting operations and mature tree maintenance
- SIS info obtained in table form
- Coordination with sidewalk staff (IPMA – Pavement and Structure Management) is currently in meetings; sidewalk record info obtained from permits and records branch (PSMA – Permitting)
- Coordination with TSA-Traffic Signals branch to learn of current and future plans as may impact tree operations

Enterprise Data Produced

- Most other divisions only care about tree locations
- In the future, tree info will be available to others as long as they have access to GIS
- Number of reports produced, including storm damage report, weekly reports of contracting activity, special reports, U.S. Forest Service reports, and performance reports (through Hansen)
- Storm damage report classifies overtime payments, extra equipment used, and breakout between trees in public space versus private space; report justifies expenditures from general operating budget and makes case when requesting more money from City Council
- Weekly report about contractors lists work completed by contractors and in-house; number of requests that needed response (to justify manpower needs)
- Special reports about how much was spent to perform some activity; ward-based statistical info; financial year-to-year historical information by ward and Advisory Neighborhood Council (ANC)
- U.S. Forest Service report comprises grants management reporting of D.C. Green Grants Program
- Permits supported under Historical Tree Preservation Bill, which requires citizens to apply and pay fees for taking down or pruning certain trees located in private space
- Performance-based ratings from Hansen which contain percentage ratings for service delivery

Current/Planned Applications

- MISTRE (Management Information System for Street Trees) contains historical data; will be retained for about three years and then phased out and archived
- CityWorks is designed to supercede MISTRE; along with GIS, takes data from Hansen and geocodes the information and creates service request
- ArcView 8.1 used as GIS; will be getting an upgrade to ArcView 8.3 once CityWorks is back up
- Hansen Call Center
- IQ stores special Hansen requests (typically from a elected officials)

- Serves

- ArcPad is a hand-held device anticipated to be online in one month; contains text (standard request form) and graphics; uses cradle for downloads and real-time synchronization occurs back on the server. Field staff can download map of specific ward; through GIS, can geocode, plot, and reconfigure tree location in the field if actual location differs from reported location.

- Use SIS (complete identification number contains SIS info including ward, street, block, side of street, and then an additional six digits to represent exact linear footage of where that street is (this is unique to Urban Forestry because they physically identify every one of their assets with a unique identifier)

Issues/Automation Needs and Opportunities

- CityWorks application provides daily data extracts (6:00 a.m. "data dump"), but ideally would have real-time data sharing especially in emergency situations where response time has to fall between two- to four-hour time window

- Seamless communication between Hansen and CityWorks (e.g., a service request is first generated in Hansen which may or may not be followed by a work request. CityWorks should be able to close the service request in Hansen if no action is taken.

- Signals from ArcPad would be sent by satellite but security reasons bar this option indefinitely; have to use the cradle system instead

- Only one back-up site on local server; no central back-up. Ideally tree info would feed and update traffic signal info for the signal division and vice versa when signal staff make changes in their data.

- Work orders done manually

- Service requests come from multiple sources (Hansen, IQ, Serves, Clearinghouse calls) and there is no way to close all the systems simultaneously once job is done; also hard to differentiate which requests are for the same issue; even if grouping is possible, liability issues prevent them from making grouping assumptions (must go out and do field investigation of each and investigate every request)

- GIS layer was made by a non-for-profit group and location ID numbers in the GIS layer (called Kasey ID numbers) do not always match that of MISTRE (MISTRE unique ID numbers); currently in the process of matching both sets of numbers; the match will be loaded into CityWorks which will reference both numbers

- Would like more use of photo images to satisfy liability issues; need a document management system for these photographs (possible FileNeT application)

- Storm damage reporting should be rolled into CityWorks application